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Send in Your Ideas

The competition on car inspection which was announced in the February issue of the *Railway Mechanical Engineer* will close on March 30. There is still time for any who are interested in this subject to send in articles to be considered for the two prizes. The editors desire especially to emphasize the fact that in addition to the prize articles any other contributions containing meritorious ideas will be published and paid for at the regular space rates. It is hoped that a considerable number of our readers will discuss this subject in order that we may be able to present a comprehensive review of car inspection practices on various railroads. The prizes, as announced last month, are $50 and $35, for the best articles on car inspection received at the New York office on or before March 30.

How to Get Results

A well-informed engineer who had spent considerable time investigating manufacturing shops recently made the statement that the results obtained in almost all plants are largely independent of the methods and equipment. This is a rather extreme statement and one which many people will be inclined not to accept. Nevertheless it must be recognized that many factors which influence the efficiency of a plant are not controlled by the quality of its equipment but rather by the degree of effectiveness with which available facilities are used. Almost anyone who has visited different railroad shops can call to mind certain plants that stood out from the rest because of systematic methods which made it possible to obtain high output. It would not be difficult to find examples to illustrate the opposite condition where shops have relatively good equipment but due to lack of system and absence of co-operation between departments, the employees fail to work together toward a definite goal and regardless of how urgently equipment is needed or how much attention the supervising officers give to rushing work through the departments the output does not come up to the standard for a well organized shop of the same size.

The majority of railroad shops are handicapped with machine tools and equipment that should have been replaced years ago. While numerous projects are now under way for additions and improvements to shops, it will be a long time before the general situation can be greatly improved. In the meantime shop foremen should not allow the poor facilities to discourage them from making every effort to get the best possible results with the equipment at hand. Often shop conditions can be materially improved by simple home-made appliances. The biggest single factor in the efficiency of a shop is the attitude of the individual workman. The foreman who combines fairness, courage and enthusiasm can usually succeed in getting men interested in their work and obtain co-operation which will get results under the most trying conditions.

Repairing Locomotives for Economy

Practically all railroad shops are now crowded to their full capacity with locomotives undergoing repairs. With insistant demands for motive power and with forces in many cases still disorganized from the strike, the situation is very trying to the foremen. When work is rushed, there is always a tendency to neglect details, and for that reason every foreman should impress upon his men that a locomotive poorly repaired usually wastes many times the amount that is saved by rushing it out of the shop. Some mechanics fail to realize how their work affects the operation of the locomotives, and the lack of such knowledge often leads to serious mistakes. For example, a boiler-maker repairing ash-pans found that the section over the trailer wheel was sometimes cut by the flange on the trailer tire. To overcome the trouble, he raised the entire ash-pan closer to the mudring, not realizing that by so doing he was reducing the efficiency of the boiler and decreasing the capacity of the locomotive. Few men, unless they have had considerable experience, understand the necessity for accurately locating the stack and alining the exhaust nozzle so that the jet will be exactly in the center. Foremen should also impress upon the men the importance of careful work in applying cylinder and valve rings, in setting valves properly, in fitting up superheater units and steam pipes so that they will stay tight, and in fact all work that affects steam consumption. The price which the railroads pay for coal at present ranges from $3 to $6 per ton, so the cost of fuel for a single trip with a large locomotive may be from $60 to $120. Giving the shopmen an understanding of the cost of locomotive fuel and the extent to which slight errors may affect the coal consumption, should have a good effect in making them more accurate in their work, and insure that locomotives which have received repairs will operate with maximum economy.

Boiler Operating Factors

The determination of factors vital to efficient boiler operation is the subject of an article in this issue worthy of special study. Considering the investment involved and the possibilities of economy or waste, too little attention is ordinarily given to the operation of railway boiler rooms by higher mechanical department officers. Unless the higher officers show a continual interest in economical boiler operation it is useless to expect the rank and file of employees to give the subject much attention, or care how much coal is wasted. In a specific case a supposedly expert fireman was shown the bad effects on furnace efficiency of too much excess air. A surprise visit two hours after giving the instructions showed him reverting to his old practice of opening the fire-doors unnecessarily. Continued effective supervision is the price of economical boiler operation.

Obviously the first place to start in saving coal (which is money) in the boiler room is at the furnace. The article re-

ferred to contains interesting data regarding combustion rates and furnace efficiencies, conditions essential to the best operation of stoker equipment, and the prevention of clinker formation. The need of simple instruments such as draft gages, recording or indicating CO_2 apparatus, steam flow meters and pyrometers is pointed out as enabling furnace conditions to be controlled so that maximum economy will result. According to the author an elaborate set of instruments is not necessary but in view of the large investment in boiler room equipment, there should be no hesitation in appropriating the relatively insignificant amount of money needed for instruments to make the investment profitable.

Records of the percentage of CO_2 obtained during two 24-hour test periods by two men firing the same boiler unit are included, and afford an interesting comparison. The relative efficiency of the two men is apparent and also the effect of excess air at fire-cleaning periods, emphasizing the value of mechanical dumps which speed up the operation. The balance of the article, devoted to the importance of high CO_2, methods of finding the combined boiler efficiency, heat balance calculations, and curves showing the cost of steam will be published next month.

Waiting To Go

Attention has been called so frequently to the large amount of idle time of locomotives and cars that some are rather weary of the repetition and others are wondering why somebody does not really do something in regard to the matter. It would be a good thing if every railroad man would ask himself whether there is not some way in which he might assist in bettering the situation. We all know that in periods of so-called car shortage, as well as in periods of car surplus, a large number of freight cars are in shops waiting to be repaired, on sidings to be unloaded or loaded, in yards waiting to be made up into trains or waiting for trains to go, or on the road waiting for cars in other trains to pass or get out of the way. Locomotives are waiting at terminals to be cleaned, coaled, inspected, repaired or are kept idle because trains are not ready for them. But little will ever be accomplished by the mechanical department putting the responsibility on the operating department—or vice versa—or by calling attention in a general way to the large part that the general shipping public play in responsibility for the unsatisfactory condition.

In this, as in so many other matters that are worth while, results can best be accomplished by direct action and by the co-operation of all parties or departments. In some places idle locomotive hours may be increased by a lack of terminal facilities—poorly arranged buildings, antiquated machine tools or an insufficient number of the proper tools. Where the size and number of locomotives have outgrown terminal facilities more lasting good can be accomplished by investments at these points than by purchasing more power. In other cases there may be a pressing need for improvements in the design of locomotives or cars, of the selection and purchase of power and rolling stock better suited for changed conditions of traffic. In still other places the standards of maintenance may be such that engine failures delay or upset plans for the movement of traffic. Hot boxes on cars are another source of annoyance and delays. Men in the mechanical department can aid materially in making it possible for a freight locomotive to average more than 80 or 90 miles a day, spending seven or eight hours on the road and the balance of the time at terminals. Freight cars also would earn far more revenue if they could be made to travel 30 miles or more a day. All indications point to a continuance of the present heavy railroad traffic. The men in the mechanical department should take this into consideration and should not try to handle their work as if this was a temporary condition but should plan to make whatever changes are necessary in facilities and methods to enable them to take care of the increased business promptly and efficiently.

Advantages of Railroad Employment

In the course of a conversation with a railroad officer the manager of a large restaurant made some comments on the railroad labor situation in which he presented a viewpoint that deserves careful consideration. Contrasting the conditions in restaurants with those on railroads he said: "I don't see why there should ever be a strike on the railroads or why the roads should have difficulty in getting high-grade men. In hiring employees for a restaurant there are very few inducements that can be offered. The work is unpleasant and monotonous, there is practically no chance for advancement and wages are low. Railroads should be able to get the pick of high-grade men because railroad work is interesting, wages are high, the pass privilege is of real value, employment is regular and the example of the men who have started at the bottom and become railroad presidents should appeal to and inspire every ambitious employee."

If the real facts regarding railroad employment could be brought to the attention of shopmen at regular intervals it would, no doubt, have a good effect in counteracting the misleading statements of those who are constantly trying to stir up discord between the managements and the employees, because the actual conditions bear out the statements quoted in the preceding paragraph. For example the report of weekly earnings in New York State factories shows that throughout the state wages of employees in railroad repair shops ranked fourth out of 64 industries and outside of New York City they ranked second. Government statistics also show that railroad shop employees have a greater continuity of employment than the workers of almost any other industry. A great deal of money is spent by propagandists to put before the workers misleading statements regarding excessive profits of the railroads and the ill feeling thus created is responsible not only for strikes but also for lessened production while the men are at work. It is time that the railroads adopted a more aggressive policy. Instead of allowing these misstatements to go unanswered railroad officers should refute them by giving publicity to reliable statistics to make railroad employees realize the fact that they are now a favored class both in the matter of wages and working conditions.

Importance of Thorough Inspection

The annual report of the Bureau of Locomotive Inspection for the year ending June 30, 1922, is gratifying in that it shows a decrease in the number of defects found by the inspectors of the bureau together with a noticeable reduction in the number of accidents, this in spite of a considerable increase in the number of locomotives inspected. These results would indicate an attempt on the part of the roads to bring their power up to a higher stage of maintenance and also good work on the part of the numerous railroad inspectors at terminal points. If the report is examined in detail it will be noted that the gain is by no means a uniform one, there being increases due to defects of certain parts, among which may be mentioned rods, motion work and trucks—leading, trailing and tender.

For some months practically all roads have been having a hard struggle to keep their motive power in operative condition and to restore conditions as soon as possible to those prevailing before the strike. The inspector is a vital factor in accomplishing this for dependence must be placed upon the carefulness with which he performs his work and makes out his reports. Thoroughness, a knowledge of where to

look and how to inspect combined with eternal vigilance, are indispensable requisites for a person in this position. A recent occurrence which might have resulted in a disastrous passenger wreck, was caused by the failure to detect a flaw and will serve as an illustration of the responsibilities and importance of the work of the inspector. While running at a high speed the rear truck on the tender of a locomotive hauling a passenger train broke down. This tender truck was immediately derailed and the locomotive broke loose from the train. Fortunately the tender did not overturn and the parts torn off the truck did not cause derailment of the cars. The truck was of the arch-bar type and the failure was due to a break in the bottom arch-bar at the point where the sharp upward bend occurs. There was an old crack more than half through the bar which must have been of long standing and yet probably had not been noticed by an inspector. This, despite the fact that failures in a truck of this type at this point are by no means so unusual that well posted inspectors would neglect to note conditions at this point. In building up a terminal force particular attention should be given to the selection and instruction of new inspectors.

New Books

SAMPLING AND ANALYSIS OF COAL, COKE AND BY-PRODUCTS; *By the Chemists' Committee of the United States Steel Corporation, 184 pages, 5 in. by 7½ in. Bound in cloth. Published by the Carnegie Steel Company, Pittsburgh, Pa.*

In order to determine accurately the properties of coal, it is essential that the right method be used in the sampling and analysis, because of the large amount of fuel bought on the basis of the contents as determined in the laboratory. The subjects treated in this book are especially important to the railroads. The fact that the method described has been approved by the foremost chemists of the constitutent companies of the Steel Corporation is sufficient evidence that the work can be considered as the best modern practice. While prepared primarily for by-product coke plants, it is well adapted for the use of railroad chemists and coal inspectors.

The first part of the book describes the method of sampling coal both at the mine and from railroad cars or belt conveyors. This is followed by a section on physical tests of coal and coke following which the methods of making approximate analyses of coal are described. The section on ultimate analysis includes methods for the determination of the different forms of sulphur in coal. The analysis of the ash is treated in detail and methods are given for determining the clinkering temperature range. The determination of the calorific value of coal and coke by the bomb calorimeter or from the ultimate or approximate analysis is discussed. The remainder of the book covers the sampling and analysis of by-products which is not of direct interest to the majority of railroad readers.

AMERICAN MALLEABLE CAST IRON. *By H. A. Schwartz. 416 pages. 6 in. by 9 in., illustrated, bound in cloth. Published by the Penton Publishing Company, Cleveland, Ohio.*

The American "black heart" malleable iron industry, which now has an annual capacity for one and a quarter million tons of castings, dates back to the discovery of the process in 1826 by Seth Boyden in a small foundry in Newark, N. J. The process is quite different from that employed in Europe for making "white heart" iron, which was first described by Reaumur in 1722. This book, which is the first complete treatise on "black heart" malleable, has been written by a recognized authority on the subject. There are chapters on the history of the industry, methods of manufacture, principles of metallurgy, procedure for tests and an outline of properties. It is made more comprehensive by the addition of a bibliography of nearly 200 references to chapters and articles in English and foreign books and periodicals, and by a well-prepared index.

From its scope, the book has evidently been written to meet the needs of the user, as well as those of the practical foundryman and the metallurgist. For the producer there are chapters in melting stock, fuel, refractories, furnaces and their operation, annealing practices, molding, patternmaking, cleaning and finishing. Inspection, tests and metallurgy are well covered together with information relative to physical, thermal and electrical properties.

As a hand book of modern malleable practice, a record of past and present metallurgical investigation, and a compendium of information on the permissible uses of the product, it should be of value to the many railroad men responsible for the design, purchase or use of malleable castings.

What Our Readers Think

A New Induced Draft Arrangement for Locomotives

SAN FRANCISCO, Calif.

TO THE EDITOR:

A contrivance that would set up an induced draft without entailing any expense either to operate or to maintain and that would prevent the smoke from wreathing about the rim

Fig. 1—Model of Front End with Air Collector and Connections to Petticoat Pipe

of the smokestack when the throttle valve is shut, obviously would be an improvement over the present blower of the steam-jet type. It also would make for safety, especially

with coal or wood fuel, since the higher the smoke as it floats past the cab, the less the chance for those riding in it to have their vision impeded or eyes injured by cinders. All known designs depend for maximum efficiency upon the current of air moving in a direction parallel to the axis of the boiler and against the front end.

The arrangement that I have devised will elevate the smoke, whether the stack is of the ordinary straight type or of my design, and, with a brisk wind, the clear distance between the boiler and the smoke as it floats to the rear will be about two-thirds again as high as the smokestack, judging from experiments with the model illustrated in Fig. 1. With the ordinary straight stack, the smoke was only slightly elevated, but the issuing smoke showed distinctly that it was moving under the influence of a strong evacuating force inside the smokebox.

Referring to Fig. 1, a broad, box-like projection will be noticed underneath the smokebox divided in the middle in such a way as to make a cavernous space as large as possible on each side. The partition should preferably taper to a sharp edge in front, instead of as shown. This attachment to the smokebox is for the purpose of catching the wind while the locomotive is running, and is connected to the petticoat pipe by two pipes which lead from the cavernous spaces to that pipe a short distance above its base, forming an acute angle therewith so that the stream of air will be diverted as little as possible in its passage to the smokestack. These branch pipes are of the same diameter and their cross-

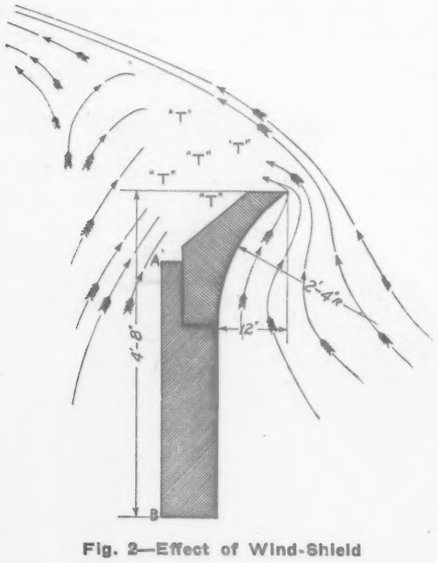
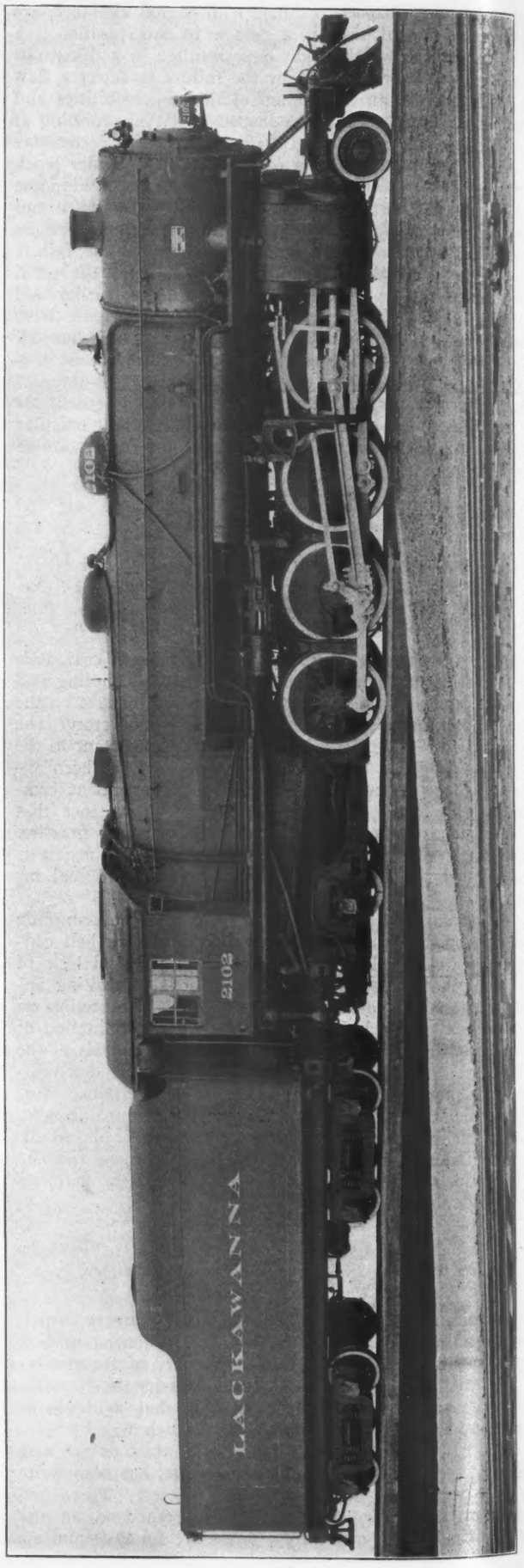


Fig. 2—Effect of Wind-Shield

sectional areas are equal in sum to that of the smokestack. They should be easily removable in order to facilitate withdrawal of the tubes.

Fig. 2 shows diagrammatically the results of the wind tunnel experiments with a wind-shield which were conducted by the Navy Department. The wind-shield is shaded, and the arrows indicate the direction of stream lines; while "T" denotes turbulence, where the air is practically still. The wind blew from right to left at right angles to AB with a velocity of 40 m.p.h. A wind-shield of this form is applied to the bridge of the battleship *California* to protect the men standing behind it and relieve them from the discomfort resulting from a strong wind. The model shown in Fig. 1 is provided with the same kind of wind-shield on the front of the smokestack. It would perhaps be better on a locomotive for the sake of looks, to have the wind-shield encircle the smokestack or to make the smokestack itself of that shape.

A Mechangineer.



The Delaware, Lackawanna & Western Mikado Type Locomotives are the Most Powerful Ever Built

Heavy Mikado Locomotive for the D. L. & W.

Lackawanna Purchases 40 of the Most Powerful Mikado Locomotives Ever Built and Postpones Contemplated Electrification

ABOUT 40 per cent of the traffic of the Delaware, Lackawanna & Western consists of anthracite coal mined in the vicinity of Scranton. Normally about 900 to 1,000 cars of coal are handled per day, part of this going west in the direction of Buffalo and more than half east to New York. Scranton and the coal mines are located in a valley, and, while there are heavy grades, about 1½ per cent, in both directions, that toward the east over the Pocono mountains is considerably longer than the westbound grades. From Scranton east to Nay Aug, about 6 miles, the grade is 77 ft. to the mile and from Nay Aug to Gouldsboro, about 14 miles, the grade is 51 ft. to the mile. These grades out of Scranton present the most difficult operating situation on the line between New York and Buffalo.

In order to equalize the operative capacity of the road plans were drawn for the electrification of some 40 miles of gradients near Scranton, the intention being to furnish electric locomotive helper and pusher service, to the summits for east and west bound traffic. The first set of bids were rejected in the summer of 1921, and later new bids were called for. As the cost of this project was in excess of $5,000,000 it was finally decided to postpone electrification for the time being and to purchase 40 powerful Mikado type locomotives at a very much smaller investment, these locomotives to be used for helper and pusher service as well as for regular road duty.

Coal trains are made up and taken through solid from Scranton to the west or to the seaboard, the necessary additional helper and pusher service being given out of Scranton. The new Mikado locomotives with the helper service mentioned are now hauling trains of 2,900 tons through from Scranton to Secaucus yard, near Hoboken.

With these powerful locomotives a larger tender is used, the capacity having been increased from 10,000 gal. of water and 12 tons of coal to 12,000 gal. of water and 14 tons of coal. This increased capacity enables the locomotives under ordinary conditions to take a train to the summit east of Scranton without taking water and to run 130 miles from Scranton to Secaucus yard without taking coal.

The 40 new locomotives for the Delaware, Lackawanna & Western are noticeably heavier than those already in service and in terms of tractive force are the most powerful Mikado locomotives ever constructed. They were designed by the American Locomotive Company to meet the special traffic conditions on the D., L. & W. and were built at the Schenectady Works. These engines bear the road numbers of 2101 to 2140 inclusive. Their weight in working order is 356,500 lb. and their normal rated tractive force is 67,700 lb. Being equipped with boosters having a rated tractive force of 11,500 lb. the total available tractive force for starting or heavy pulls is 79,200 lb. or 17 per cent over that of the locomotive cylinders alone. The locomotive cylinders are 28 in. by 32 in. and the driving wheels are 63 in. in diameter.

The D., L. & W. has been a user of heavy Mikado locomotives in the past, having purchased 74 locomotives of the 1200 class which are essentially alike. The last order from this design was for 10 locomotives placed in 1920. These also were built by the American Locomotive Company. A comparison of the dimensions, weights, and proportion of the two designs will be found in the accompanying table.

It will be noticed from this table that the new Mikado locomotives have 10,600 lb. greater tractive force than those previously used, an increase of 18½ per cent for the main cylinders, and an increase of 22,100 lb. or 38½ per cent if the booster is included. The increase in tractive force of the main cylinders was obtained by changing the piston travel from 30 in. to 32 in. and raising the steam pressure from 180 lb. to 200 lb. The weight of the engine in working order was raised from 328,000 lb. to 356,500 lb., an increase of 8.7 per cent and the weight on the drivers from 256,000 lb. to 271,500 lb., an increase of slightly over 6 per cent. An axle load of 68,000 lb. would of course not have been permissible except for the favorable track and bridge conditions prevailing on the Lackawanna. The fact that an increase of 38½ per cent in total available tractive force was obtained by an increase of only 8.7 per cent in the total weight of the engine is an excellent example of what can be done by good designing combined with the introduction of the booster.

The diameter of the boiler was increased from 84¼ in. to 90-5/16 in., inside the first ring, while the length of the firebox was increased 12⅛ in. without change in width, the grate area thereby being increased from 63.2 sq. ft. to 70.4 sq. ft. The length over the tube sheets of 18 ft. was retained but the number of 2 in. tubes was decreased from 303 to 300 and the number of 5⅜ in. flues increased from 43 to 50. The total evaporative heating surface was increased 3.9 per cent while the increase in superheating surface was 16.75 per cent. In the new locomotives the superheating surface is 25.2 per cent of the evaporative heating surface, a liberal allowance. Superheated steam is used not only for the main cylinders but also for the booster, the connection for the latter being made from the outside steam pipes. A combination exhaust stand is used for the locomotive and the booster cylinders.

A comparison between the calculated cylinder horsepower, and the calculated boiler horsepower shows they are practically the same and would indicate that these locomotives could be relied upon to be excellent steamers. The estimated coal rate when working at full capacity is 130 lb. per square foot of grate per hour. Stokers are provided, those for the new engines being furnished by The Elvin Mechanical Stoker Company.

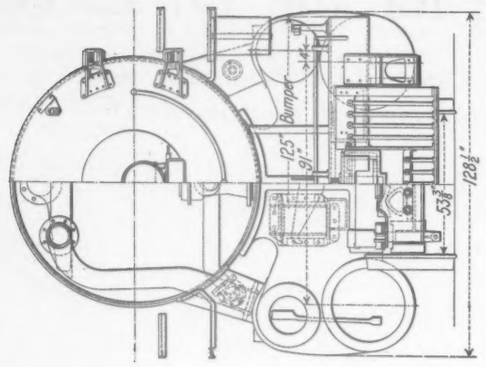
The driving wheels of both the old and the new design are 63 in. in diameter. The main driving journals of the new engines are 12 in. by 20 in., the front journals 10½ in. by 18 in. and the others 10½ in. by 16 in. By using lateral motion driving boxes for the forward drivers the rigid wheel base is reduced to 11 ft. 4 in. The front trucks are of the Woodard type and the trailing trucks of the Delta type. Baker valve gear with 14 in. piston valves is used on both designs. Chrome-Vanadium steel was used for the main and side rods in order to keep their weight as low as possible and thus minimize the dynamic augment.

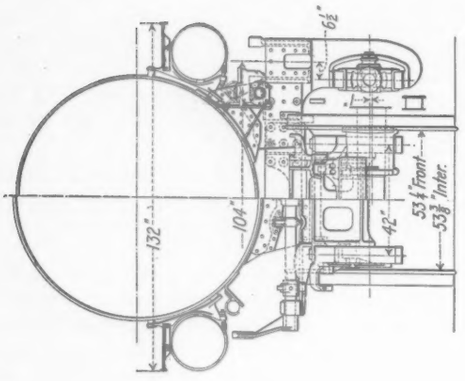
The height of the new D., L. & W. Mikado locomotive is 15 ft. 4⅛ in., the extreme width 11 ft. and the coupled length of locomotive and tender 84 ft. 5½ in. The smoke stack is 18 in. in diameter and the single exhaust nozzle 7 in. in diameter.

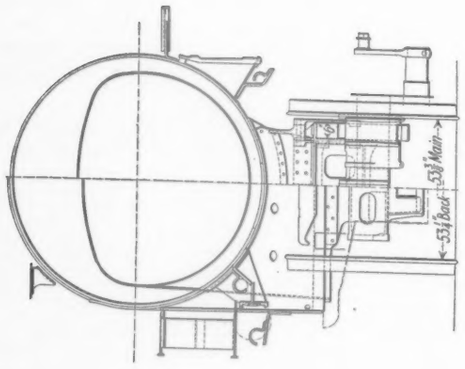
In addition to the booster, Elvin mechanical stoker and Baker valve gear other special equipment on these locomotives are the Alco power reverse gear, power grate shaker, automatic fire door of the Butterfly type, Pyle electric headlight and Cleveland low water alarm.

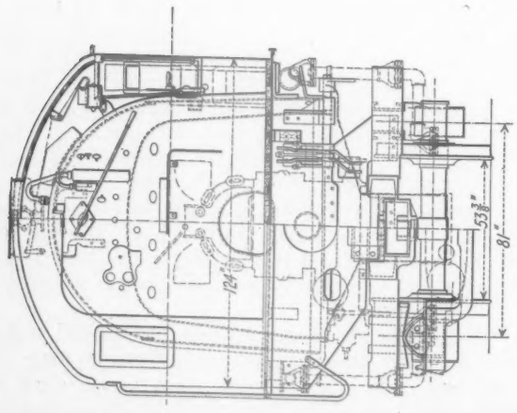
While the curvature on the main line of the Lackawanna

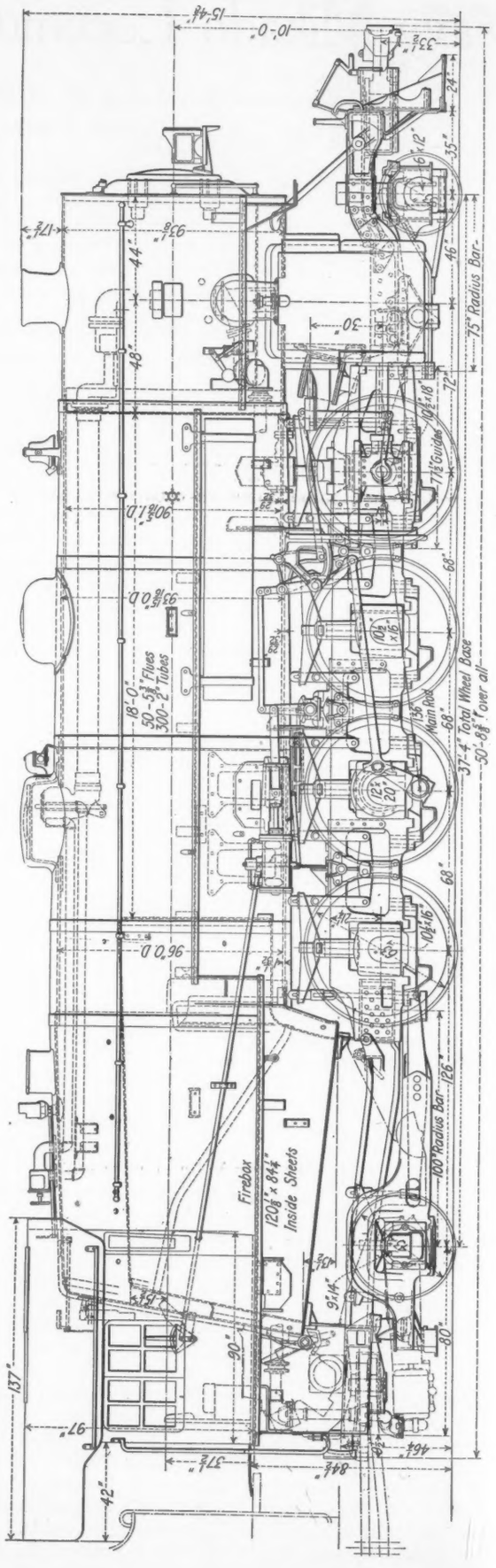
The Delaware, Lackawanna & Western Mikado Type Locomotives are the Most Powerful Ever Built











Cross-Sections and Elevation of the Delaware, Lackawanna & Western Mikado Type Locomotive

is moderate and while lateral motion driving boxes and a short rigid wheel base have reduced hub wear and flange wear to a relatively small amount, Chicago hydrostatic flange lubricators are installed to still further reduce the flange wear and decrease the friction on curves.

Conditions on the Lackawanna call for considerable drifting of locomotives. For this reason Talmage drifting valves have been applied to the new Mikados so that it is not necessary to run with a cracked throttle.

To avoid breakage and damage of the pilot drawgear when locomotives are used in pusher and helper service Miner friction draft gear is employed on the head end of these locomotives.

These D., L. & W. Mikado locomotives will naturally be compared with those for the New York Central Lines, one of the most striking designs brought out in 1922 and for which orders were placed for 191 for the various roads comprising that system. The New York Central engines weigh 334,000 lb. in working order, have 28 in. by 30 in. cylinders, and 63 in. driving wheels. They also are equipped with boosters and have a total rated tractive force of 74,500 lb. or 63,500 lb. without the booster. They were fully described in the *Railway Mechanical Engineer*, September, 1922. Other heavy Mikado type locomotives recently ordered are those for the Central of New Jersey weighing 342,500 lb., having 27 in. by 32 in. cylinders and a rated tractive force of 59,000 lb. and those for the Northern Pacific weighing 337,000 lb., having 28 in. by 30 in. cylinders, and a rated tractive force of 57,000 lb. But few Mikado locomotives having a tractive force of over 60,000 lb. have been built.

DIMENSIONS, WEIGHTS AND PROPORTIONS—D., L. & W. MIKADO LOCOMOTIVES

	2100 class	1200 class
Type of locomotive	2-8-2	2-8-2
Cylinders, diameter and stroke	28 in. by 32 in.	28 in. by 30 in.
Valve gear, type	Baker	Baker
Valves, piston type, size	14 in.	14 in.
Maximum travel	7 in.	6¾ in.
Outside lap	1 1/16 in.	1 1/16 in.
Exhaust clearance	0	0
Lead in full gear	1/8 in.	1/8 in.
Weights in working order:		
On drivers	271,500 lb.	256,000 lb.
On front truck	25,500 lb.	23,500 lb.
On trailing truck	59,500 lb.	48,500 in.
Total engine	356,500 lb.	328,000 lb.
Tender	217,600 lb.	178,000 lb.
Wheel bases:		
Driving	17 ft. 0 in.	17 ft. 0 in.
Rigid	11 ft. 4 in.	11 ft. 4 in.
Total engine	37 ft. 4 in.	35 ft. 2 in.
Total engine and tender	73 ft. 2½ in.	70 ft. 9½ in.
Wheels, diameter outside tires:		
Driving	63 in.	63 in.
Front truck	33 in.	33 in.
Trailing truck	43 in.	43 in.
Journals, diameter and length:		
Driving, main	12 in. by 20 in.	11 in. by 21 in.
Driving, front	10½ in. by 18 in.	10½ in. by 18 in.
Driving, others	10½ in. by 16 in.	10½ in. by 13 in.
Front truck	6 in. by 12 in.	6 in. by 12 in.
Trailing truck	9 in. by 14 in.	9 in. by 14 in.
Boiler:		
Type	Straight top	Conical con.
Steam pressure	200 lb.	180 lb.
Fuel	Bit. coal	Bit. coal
Diameter, first ring, inside	90 5/16 in.	84¼ in.
Firebox, length and width	120⅛ in. by 84¼ in.	108 in. by 84¼ in.
Height mud ring to crown sheet, back	72½ in.	.....
Height mud ring to crown sheet, front	92½ in.	.....
Arch tubes, number and diameter	4—3 in.	4—3 in.
Combustion chamber, length	45 in.	36¾ in.
Tubes, number and diameter	300—2 in.	303—2 in.
Flues, number and diameter	50—5⅜ in.	43—5⅜ in.
Length over tube sheets	18 ft. 0 in.	18 ft. 0 in.
Tube spacing	13/16 in.	¾ in.
Gas area through tubes	730 sq. in.	737 sq. in.
Net gas area through flues	659 sq. in.	567 sq. in.
Total gas area through tubes and flues	1,389 sq. in.	1,304 sq. in.
Grate type	Rocking	Rocking
Grate area	70.4 sq. ft.	63.2 sq. ft.
Heating surfaces:		
Firebox and comb. chamber	315 sq. ft.	300 sq. ft.
Arch tubes	30 sq. ft.	28 sq. ft.
Tubes	2,813 sq. ft.	2,840 sq. ft.
Flues	1,260 sq. ft.	1,083 sq. ft.
Total evaporative	4,418 sq. ft.	4,251 sq. ft.
Superheating	1,112 sq. ft.	953 sq. ft.
Comb. evaporative and superheat'g	5,530 sq. ft.	5,204 sq. ft.
Special equipment:		
Brick arch	Yes	Yes
Superheater	Type A	Type A
Feedwater heater	No	No
Stoker	Elvin	Duplex
Booster	Yes	No
Tender:		
Style	Waterleg Acme	Waterleg
Water capacity	12,000 gal.	10,000 gal.
Fuel capacity	14 tons	12 tons
General data, estimated:		
Rated tractive force, 85 per cent.	67,700 lb.	57,100 lb.
Rated tractive force with booster.	79,200 lb.	.....
Cylinder horsepower (Cole)	2,824	2,542
Boiler horsepower (Cole) (est.)	2,805	2,645
Speed at 1,000 ft. piston speed	35.2 m.p.h.	37.5 m.p.h.
Steam required per hour	58,700 lb.	55,000 lb.
Boiler evaporative capacity per hr.	58,330 lb.	52,900 lb.
Coal required per hour, total	9,180 lb.	8,260 lb.
Coal rate per sq. ft. grate per hr.	130 lb.	131 lb.
Weight proportions:		
Weight on drivers ÷ total weight engine, per cent	76.1	78.0
Weight on drivers ÷ tractive force	4.01	4.48
Total weight engine ÷ cylinder hp.	126 lb.	129 lb.
Total weight engine ÷ boiler hp.	127 lb.	124 lb.
Total weight engine ÷ comb. heat. surface	64.5 lb.	63.0 lb.
Boiler proportions:		
Boiler hp. ÷ cylinder hp., per cent.	99.3	104
Comb. heat. surface ÷ cylinder hp.	1.96	2.05
Tractive force ÷ comb. heat. surf.	12.23	10.97
Tractive force × dia. drivers ÷ comb. heat. surface	771	691
Cylinder hp. ÷ grate area	40.1	40.2
Firebox heat surface ÷ grate area.	4.9	5.2
Cylinder hp. ÷ gas area (tubes and flues)	2.03	1.95
Firebox heat. surface, per cent of evap. heat. surface	7.8	7.7
Superheat. surface, per cent of evap. heat. surface	25.2	22.4
Tube length ÷ inside diameter	122.7	122.7

COMMON INTERESTS OF ROADS AND EMPLOYEES.—W. G. Lee, president, Brotherhood of Railroad Trainmen, in an address before the Western Railway Club, Chicago, February 19, 1923, called attention to the need of better acquaintance between managers and employees and the fact that as long as the public believes the charges of each against the other, both managements and men will suffer. "You ask. 'What else have you to offer in place of the strike?' Gentlemen, I have the greatest confidence in the personal acquaintance of men with each other. I realize how impossible it is for the managers of our great railway corporations to be acquainted with their employees, but if you ever can reach the time when the men can understand that the company for which they work is not represented solely by so many engines and box cars, but is represented by men like themselves, who have an interest in the employees as well as in the revenues, you will have accomplished something that as yet has not entirely been done. It is useless to denounce the strike as a barbaric method for adjusting disputes so long as there are no more humane methods. We agree that the court of force is an unjust court, but we have not yet found a better one when both sides fail to agree. Railroad employees are not unreasonable. They are willing to go half way at any time, but they realize their necessities and are not slow in endeavoring to provide for them. The public has been diverted in the past few years by public statements made by railroad companies and their employees. The roads have said that transportation employees were extravagantly paid, that they had the easiest positions and the highest pay of any employees in the country, and that further concessions granted them simply meant robbing the public pocketbook, which, in this instance, the railroad companies were quite prepared to protect. The railroad employees have countered by setting forth that the railway companies were extravagantly operated, that because of watered stocks, dishonest management and inefficient operation they were, in very many instances, not showing the revenues they should, and insisting that if they were given honest management, there would be no difficulty in meeting the wage demands of their employees. Whether we agree on all subjects that come between us or not, we must agree that in the public estimation the railroad companies and their employees are not separated. The public accepts both statements as gospel truth and exacts its toll of transportation service at its own price against both of them. Let us satisfy the public that the railway companies and their employees are not what they have called each other, but that they are exactly the contrary; that they are serving the transportation needs of this country in a more efficient manner than they are being served in any other country in the world; that the railroad companies are efficiently managed; that their employees are giving efficient service, and that both of them are worthy of their hire."

Freight Train Resistance and Tonnage Ratings

Part II

Formula for Adjusted Ratings, Selection of Values and Analysis of the Adjustment

By Richard J. McCarty, Jr.
Division Superintendent, Delaware & Hudson

ADJUSTED tonnage ratings can be established either by test or by calculation. In either case it is first necessary to select as a basis for the adjustment two cars of unequal weight, one to represent light weight cars and the other, loaded cars. The weight of these cars should represent closely the operating conditions under consideration.

When by test the number of tons and cars of light cars and the number of tons and cars of heavy cars that can be moved over a given district with a given unit of motive power have been found, divide the difference in tons by the difference in the cars to get the adjustment in tons per car. Then multiply the adjustment by the number of light cars and add the result to the actual tons of light cars which gives the adjusted rating. The same result can be obtained by multiplying the number of heavy cars by the adjustment and adding the result to the actual tons of heavy cars. From this method it will be seen that after the adjustment has been obtained, the adjusted rating may be derived from the data of either train. The efficiency of ratings secured in this manner depends on selecting car weights that properly represent the conditions of traffic for the particular district.

Formula for Adjusted Ratings

Ordinarily, to obtain an adjusted rating by calculation it would be necessary to select the proper unit values of resistance to represent the two cars of unequal weight, above mentioned, and then work out the actual tons of the train of light cars and the actual tons of the train of heavy cars and proceed as shown above, where the data is obtained by test. A formula can be developed, however, that will simplify this process, and the manner in which it is done will now be described.

In order that the formula in question will represent all conditions the symbols of Table V* will be used. The number of tons a given drawbar pull will move is found by dividing the drawbar pull by the sum of the different elements of resistance in pounds per ton. As either weight car may be taken as a basis on which to calculate the adjusted rating, a train of light weight cars will be taken.

Then the tons may be represented by the following formula:

$$T = \frac{f}{E + G} \qquad (27)$$

From equation (5) the number of cars is as follows:

$$C = \frac{T}{W} \qquad (28)$$

Having now developed the part of the formula for the actual tons and the number of cars, it is next in order to develop a formula for the adjustment for use in connection with equation (27) and (28).

From fundamental equations (6) and (10)

$$T(E + G) = (T + t)(E - e + G) \qquad (29)$$

Therefore

$$t = \frac{fe}{(E + G)(E - e + G)} \qquad (30)$$

From (7) and (11)

$$C(R + D) = (C - c)(R + r + D + d) \qquad (31)$$

Therefore

$$c = \frac{f(r + d)}{(R + D)(R + r + D + d)} \qquad (32)$$

Then from (30) and (32) any adjustment may be expressed as follows:

$$\frac{t}{c} = \frac{e(R + D)(R + r + D + d)}{(r + d)(E + G)(E - e + G)} \qquad (33)$$

$$= W(W + w)\frac{e}{r + d} \qquad (34)$$

$$= \frac{Rw - rW}{r + d} \qquad (35)$$

* See February issue, page 85.

As between any two trains of the same total resistance on any given district, but of different weight cars, respectively,

Equation (30) represents the difference in the tons.

Equation (32) represents the difference in the number of cars.

Equations (33), (34) and (35) represent the adjustment.

As equations (33) to (35) inclusive provide for all conditions of operation either of them may be used for obtaining the adjustment from fundamental unit values, although the most convenient formula is equation (34). Therefore, the formula for the adjustment may be expressed as follows:

$$\text{Adjustment} = W(W + w)\frac{e}{r + d} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (36)$$

From the above it will be seen that the value of the adjustment depends on the weights of the two cars selected and on the value of the corresponding units of mechanical and grade resistance, also it is independent of drawbar pull. Stated in general terms, which will be sufficient for the present, it represents in tons the relation that exists between the values of mechanical resistance and the value of grade resistance for cars of unequal weight.

By combining equations (27), (28) and (36) the adjusted tonnage rating for any given unit of motive power over any given district may be expressed in the following formula:

$$\text{Adjusted tons} = \frac{f}{E + G} + CW(W + w)\frac{e}{r + d} \quad \ldots\ldots\ldots\ldots\ldots\ldots (37)$$

in which

$$\frac{f}{E + G} = \text{Actual tons} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (38)$$

$$W(W + w)\frac{e}{r + d} = \text{Adjustment} \quad \ldots\ldots\ldots\ldots\ldots\ldots (39)$$

and

$$CW(W + w)\frac{e}{r + d} = \text{Potential tons} \quad \ldots\ldots\ldots\ldots (40)$$

Equation (37) is the basic formula and represents all the conditions that are involved in adjusted ratings. When this formula is applied to practical purposes, however, it is necessary to select car weights and resistances that fit the conditions of operation, and therefore a number of the unknown quantities become known, which makes it possible to reduce the formula so it can be easily applied. For example, suppose car weights and units of resistance for a given division are selected as follows:

Light cars	20 tons
Heavier cars	60 tons
Mechanical resistance of lighter cars	6.8 lb. per ton
Mechanical resistance of heavier cars	3.3 lb. per ton

By substituting these values in equation (37)

$$\text{Adjusted tons} = \frac{f\,(d + 272)}{(G + 6.8)\,(d + 62)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (41)$$

A formula similar to equation (37), and one that will produce the same result, may be derived by using as a basis the resistance of the heavier cars instead of the lighter cars, by which

$$\text{Adjusted tons} = \frac{f\,(d + 132)}{(G + 3.3)\,(d + 62)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (42)$$

Equations (41) and (42) both give the same result and the adjustment in both cases is the same.

After the proper car weights and car resistances have been selected for a given railroad, a simple formula for the adjustment for any grade may be derived from equation (39). For example, the use of the same values in equation (39) as were used in equation (37) gives,

$$\text{Adjustment} = \frac{4200}{d + 62} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (43)$$

in which there is only one unknown quantity of easy determination.

Any adjusted rating is made up of two parts; *viz.*, the actual tons and the potential tons. In order to make up a train of a given adjusted rating the adjustment should be added to the actual weight of each car as the car weights are added up until the sum of the actual weights and the adjustments equals the adjusted rating.

Assuming that the rate of grade is accurately known, the efficiency of any adjusted rating depends on selecting car weights that closely represent the conditions of operation, and on selecting values of resistance to represent such cars. If this is properly done an adjusted rating and an adjustment can be developed for any given district that will produce trains of approximately the same total resistance regardless of car weights.

Selection of Values for Use in Adjusted Tonnage Formula

In discussing this phase of the subject, equation (38) which gives the actual tons, will be taken first, after which the adjustment will be analyzed.

In selecting values for mechanical resistance, grade resistance and curve resistance, a great deal depends on conditions and, therefore, care should be taken to see that the values selected fit the physical characteristics and operating conditions as near as possible.

Although the mechanical resistance from the time a train starts until it reaches the speed of minimum friction is greater than the mechanical resistance at 5 or 10 miles per hour, it is not necessary to consider the higher resistances, because they are overcome by the proper handling of the slack as previously explained, and by a temporary advantage of low piston speed. In this way mechanical resistance in pounds per ton for the speed of minimum friction, which is between 5 and 10 miles per hour, becomes the governing feature.

There are in existence a good many tables of mechanical resistance for freight cars of different weights at various speeds and in a large number of them there is considerable difference in the respective values. In view of this it is important to know under what conditions any given values of mechanical resistance were obtained before adopting them as a basis for adjusted ratings.

The amount to allow for acceleration depends on the physical characteristics of the railroad and on the density of traffic. It has been assumed, however, that in the present treatment of the subject, no allowance will be made for acceleration.

Grade resistance and curve resistance are constant amounts for any given grade or curve and, therefore, the selection of these amounts should be governed by the remarks given under "Grades and Curves." In cases where the ruling grade can be approached at high freight train speed and where it is safe to assume that this can be done, as a general proposition, it is proper to consider such a grade as a momentum grade and take credit for the difference. This difference can be calculated by the usual formula,

$$g = 3.5 \times \frac{V_2^2 - V_1^2}{L} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (44)$$

where g = Per cent of grade to be deducted from the actual grade.
V_2 = Initial speed in miles per hour.
V_1 = Speed at top of grade in miles per hour.
L = Length of grade in feet.

When the value of (g) in such cases has been obtained it should be deducted from the value of the ruling grade in per cent, and the balance which represents the per cent of the momentum grade, used to obtain the grade resistance for use in the formula previously described.

When the car weights and values of resistance have been decided upon in connection with the calculation of the actual tons, the same values should be used as a basis for obtaining the adjustment, for otherwise the ratings will be over-adjusted or under-adjusted, the effects of which will appear presently.

Unless these features in connection with the selection of

values are properly handled, the adjusted ratings are apt to prove inefficient.

The adjustment, which embodies the principles of adjusted ratings, will now be analyzed so as to show the fundamental values by which it is produced, and so as to show what effect any variation in each value has on the adjustment.

Analysis of the Adjustment

A general description of what the adjustment represents will now be given after which it will be analyzed with respect to its value under different conditions.

The difference in the units of mechanical resistance produce the difference in the tons of trains of the same total resistance as previously explained, but grade resistance tends to offset this condition and, as will be seen later, the steeper the grade the less will be the effect of the difference in mechanical resistance per ton as between cars of different weight.

A complete analysis of the adjustment divides itself naturally into two steps, the first of which takes into consideration its value with respect to straight and level track conditions only, while the second step involves grades and curves. This process would be beneficial to the student but it involves considerable duplication, and therefore as space will not permit, the analysis will be based on conditions that involve both mechanical and grade resistance.

The first step, however, can be followed by referring to Table III* and particularly to Exhibit A specially prepared to illustrate conditions when only mechanical resistance is considered, while Table IV* and Exhibit B should be referred to as the basis for the following analysis.

Before taking up the analysis, however, a few words of explanation may help to an understanding of Exhibits A and B.

In Exhibit A, the train of lighter cars exceeds the train of heavier cars in regard to the number of cars, while the train of heavier cars exceeds the train of lighter cars in regard to the number of tons.

The mechanical resistance per ton of the lighter car train exceeds the mechanical resistance per ton of the heavier car train.

* See February issue, page 85.

EXHIBIT "A"

Comparative Analysis of the Mechanical Resistance of the Lighter Car Train and the Heavier Car Train as Per Table III. Straight and Level Track—Speed 5 Miles Per Hour

	No. of cars involved in each item	Weight per car in tons: Car	Weight per car in tons: Contents	Tons involved in each item	Rate at which tons or cars are moved—mechanical resist.: Lb. per ton	Rate at which tons or cars are moved—mechanical resist.: Lb. per car	Total M. R. for each component item—tons or cars	Diff. in M. R. that moves the incr. in tons of the heavier train	Expression by formula
	Lighter Car Train:								
	68	20	....	1,360	3.3	66	4,488	.....	
A	63	20	....	1,360	3.5	70	4,760	4,760	(C — c)We
	Total ..	20	....	1,360	6.8	135	9,248	.....	
	Excess Over Heavier Car Train (Cars):								
	31	20	....	620	3.3	66	2,046	.....	
B	31	20	....	620	3.5	70	2,170	2,170	cWe
	Total ..	20	....	620	6.8	136	4,216	.....	
	Total train (99 cars)	20	....	1,980	6.8	136	13,464	6,930	CWe = Te = t(E — e)
	Heavier Car Train:								
	68	20	....	1,360	3.3	66	4,488	.....	
C	68	..	9.11	620	3.3	132	2,046	.....	
	Total ..	20	9.11	1,980	3.3	...	6,534	.....	
	Excess Over Lighter Car Train (Tons):								
	68	..	21.21	1,442	3.3	...	4,760	4,760	(C — c)We
D	63	..	9.68	658	3.3	...	2,170	2,170	cWe
	63	..	30.89	2,100	3.3	132	6,930	6,930	CWe = te = t(E — e)
	Total train (68 cars)	20	40	4,080	3.3	198	13,464	.....	

$$\frac{t}{c} = \frac{2100}{31} = 67.74 \text{ tons per car} = \text{Adjustment for above conditions.}$$

EXHIBIT "B"

Comparative Analysis of the Mechanical Resistance and Grade Resistance of the Lighter Train and the Heavier Train, as Per Table IV. Grade 1 Per Cent—Speed 5 Miles Per Hour

	No. cars involved in each item	Weight per car in tons: Car	Weight per car in tons: Contents	Tons involved in each item	Rate at which tons and cars are moved: Mech. Resis. Lb. per ton	Mech. Resis. Lb. per car	Grade. Resis. Lb. per ton	Grade. Resis. Lb. per car	M. R. for each component item—tons or car	G. R. for each component item—tons or car	Total res. for each component item—tons or car	Distribution of dif. in M. R. that moves the incr. in tons of the heavier train	(Formula)
	Lighter Car Train:												
	9.63	20	.....	192.6	3.3	66	20	400	636	.....	.....	.....	
A	9.63	20	.....	192.6	3.5	70	20	400	674	.....	.....	674	(C — c)We
	Total	20	.....	192.6	6.8	136	20	400	1,310	3,852	5,162	.....	
	Excess Over Heavier Car Train (Cars):												
	15.49	20	.....	309.8	3.3	66	20	400	1,022	.....	.....	.....	
B	15.49	20	.....	309.8	3.5	70	20	400	1,084	.....	.....	1,084	cWe
	Total	20	.....	309.8	6.8	136	20	400	2,106	6,196	8.302	.....	
	Tot. 25.12	20	.....	502.4	6.8	136	20	400	3,416	10,048	13,464	1,758	CWe = Te = t(E — e + G)
	Heavier Car Train:												
	9.63	20	.....	192.6	3.3	66	20	400	636	3,852	4,488	.....	
C	9.63	..	32.17	309.8	3.3	132	20	400	1,022	6,196	7,218	.....	
	Total	20	32.17	502.4	3.3	...	20	...	1,658	10,048	11,706	.....	
	Excess Over Lighter Car Train (Tons):												
	9.63	..	3.60	28.9	3.3	...	20	...	96	578	674	674	(C — c)We
D	9.63	..	4.83	46.6	3.3	...	20	...	152	932	1,084	1,084	cWe
	9.63	..	7.83	75.5	3.3	132	20	800	248	1,510	1,758	1,758	CWe = Te = t(E — e + G)
	Tot. 9.63	20	40.00	577.9	3.3	198	20	200	1,906	11,558	13,464	.....	

$$\frac{t}{c} = \frac{75.5}{15.49} = 4.87 \text{ tons per car} = \text{Adjustment for above conditions.}$$

The items opposite A show the resistances involved in the same number of lighter cars as are involved in the total number of cars of the heavier car train divided so as to show mechanical resistance resulting from the same resistance in pounds per ton as the heavier cars and also mechanical resistance resulting from the increase in mechanical resistance of the lighter cars as compared to the heavier cars.

Item B covers the same features as item A except that the items apply to the excess number of cars of the lighter car train as compared to the number of cars of the heavier car train.

The items opposite C show the resistance involved in the same number of tons of the heavier car train as compared to the total number of tons of the lighter car train divided as between the empty cars and the contents, both of which, however, are carried at the same mechanical resistance in pounds per ton.

Item D covers the same features as item C except that the items apply to the excess number of tons of the heavier car train as compared to the lighter car train which, however, involve only the contents of such cars for the reason that the cars themselves are covered under item C.

The details thus developed under items A, B, C and D show the distribution of the details of mechanical resistance involved in comparing the lighter car train to the heavier car train without any change in numerical values of the details.

Exhibit B is built up on the same principle as that involved in Exhibit A and although Exhibit B includes grade resistance, the explanations relative to Exhibit A may be applied to this exhibit, bearing in mind that the grade resistance changes the distribution of various items of resistance as between details.

With these explanations an analysis of the adjustment can be taken up.

The fundamental equations give a comparison of the total resistance of these trains as follows:

From (8) and (12) $CW(E+G) = (C-c)(W+w)(E-e+G) = f$..(45)
From (6) and (10) $T(E+G) = (T+t)(E-e+G) = f$.....(46)
From (7) and (11) $C(R+D) = (C-c)(R+r+D+d) = f$...(47)

From equation (46) it will be seen that the increase in tons (t) of the heavier car train is the result of a decrease in the mechanical resistance in pounds per ton (e) of the heavier cars compared to the lighter cars.

Therefore, from equations (45) and (46)

$$t(E-e+G) = CW(E+G) - CW(E-e+G) = CWe = Te \quad ..(48)$$

$$\text{or, } t = \frac{CW(E+G) - CW(E-e+G)}{(E-e+G)} = \frac{CWe}{(E-e+G)} = \frac{Te}{(E-e+G)} \quad (49)$$

which means that the increase in the tons of the heavier car train as compared to the lighter car train has the same mechanical and grade resistance per ton as the heavier cars and that the total mechanical and grade resistance of this difference in the tons, is equal to the mechanical resistance that is caused in the lighter car train by the increase in mechanical resistance per ton of the lighter cars as compared to the heavier cars.

From equation (47) it will be seen that the decrease in the number of cars (c) of the heavier car train is the result of an increase in the mechanical and grade resistance in pounds per car $(r+d)$ of the heavier cars compared to the lighter cars.

Therefore from equations (45) and (47)

$$c(R+D) = cW(E+G) = (C-c)(r+d) \quad .....(50)$$

$$\text{or, } c = \frac{cW(E+G)}{R+D} = \frac{(C-c)(r+d)}{R+D} \quad .....(51)$$

which means that the mechanical and grade resistance of the difference in the number of cars is equal to the increase in the mechanical and grade resistance of the heavier cars of the heavier car train compared to the same number of lighter cars.

The relation of these items of resistance to each other as between trains of unequal weight is shown in Exhibit "B."

From the above it follows that the difference in the tons (t) divided by the difference in the cars (c) represents the amount of tons the heavier car train is increased in weight for every car of the difference in the number of cars.

From (34) $\frac{t}{c} = W(W+w)\frac{e}{r+d}$ = Adjustment.

Therefore $t = cW(W+w)\frac{e}{r+d}$ .....(52)

In other words, each car of the lighter or longer train in excess of those in the heavier or shorter train is represented in the actual tons of the heavier or shorter train by $\frac{t}{c}$ tons, or all the cars in excess are represented by $c - \frac{t}{c}$ tons which equals (t) as shown in equation (13).

The value of the adjustment for a 1 per cent grade, with the unit values given in Table IV*, is 4.87 tons per car which will adjust the ratings so they will produce trains of the same total resistance regardless of whether the trains are made up of 20-ton cars, 60-ton cars or both kinds of cars.

Exhibits "C" and "D" give a comparison of trains made up of mixed cars. From these exhibits it will be seen that in any given adjusted rating with corresponding car weights, the total resistance of any train of that rating is constant

EXHIBIT "C"

APPLICATION OF ADJUSTED RATINGS TO TRAINS MADE UP OF CARS OF UNEQUAL WEIGHT. STRAIGHT AND LEVEL TRACK—SPEED 5 MILES PER HOUR

Items (resist. in lb)	Basis of adjustment: 20 ton cars	Basis of adjustment: 60 ton cars	Trains of 20 and 60 ton cars	Diff. compared to: Tr. of 20 ton cars	Diff. compared to: Tr. of 60 ton cars
M. R. per ton	6.8	3.3	6.8 & 3.3	.....	.....
Grade res. per ton	.....	.....	.....	.....	.....
M. R. per car	136	198	136 & 198	.....	.....
Grade res. per car	.....	.....	.....	.....	.....
No. of 20 tons cars	99	.....	51	.....	.....
No. of 60 ton cars	.....	68	33	.....	.....
Total No. of cars	99	68	84	—15	+16
Total M. res.	13,464	13,464	13,464	0	0
Total grade res.	.....	.....	.....	.....	.....
Total all res.	13,464	13,464	13,464	0	0
The above trains on adjusted tonnage rating basis:					
Adjustment	67.74	67.74	67.74	.....	.....
Actual tons	1,980	4,080	3,000	+1,020	—1,080
Potential tons	6,706	4,606	5,686	—1,020	+1,080
Adjusted tons	8,686	8,686	8,686	0	0
Diff. in act. tons divided by diff. in cars	.....	.....	.....	68	68

EXHIBIT "D"

APPLICATION OF ADJUSTED RATINGS TO TRAINS MADE UP OF CARS OF UNEQUAL WEIGHT. GRADE 1 PER CENT—SPEED 5 MILES PER HOUR

Items (resist. in lb.)	Basis of adjustment: 20 ton cars	Basis of adjustment: 60 ton cars	Trains of 20 and 60 ton cars	Diff. compared to: Tr. of 20 ton cars	Diff. compared to: Tr. of 60 ton cars
M. R. per ton	6.8	3.3	6.8 & 3.3	.....	.....
Grade res. per ton	20.00	20.00	20.00	.....	.....
M. R. per car	136	198	136 & 198	.....	.....
Grade res. per car	400	1,200	400 & 1,200	.....	.....
No. of 20 ton cars	25.12	.....	5.00	.....	.....
No. of 60 ton cars	.....	9.63	7.71	.....	.....
Total No. of cars	25.12	9.63	12.71	—12.41	+3.08
Total M. res.	3,416	1,907	2,212	—1,204	+305
Total grade res.	10,048	11,557	11,252	+1,204	—305
Total all res.	13,464	13,464	13,464	0	0
The above trains on adjusted tonnage rating basis:					
Adjustment	4.87	4.87	4.87	.....	.....
Actual tons	502.4	577.9	562.6	+60.2	—15.3
Potential tons	122.3	46.8	62.1	—60.2	+15.3
Adjusted tons	624.7	624.7	624.7	0	0
Diff. in act. tons divided by diff. in cars	.....	.....	.....	4.87	4.87

* See February issue, page 85.

regardless of whether the cars making up the train are light, heavy or mixed, but the adjustment by which this is done is not the same for all cases.

From the foregoing description of the adjustment the following corollaries may be deduced:

4—The basis of any adjustment is primarily the difference in mechanical resistance in pounds per ton for cars of unequal weight, but its value depends on the relation that this difference bears to the total resistance in pounds per ton of both cars.

5—In any given adjusted rating, the adjustment represents the number of tons that any train of that rating may be increased in weight for every car the train is shortened, provided the train is to some extent a mixture of cars of the same weights as were used to obtain the adjustment.

The formula for the adjustment is as follows:

$$\frac{t}{c} = W\ (W + w)\ \frac{e}{r + d} \qquad \text{From (36)}$$

By inspection the following corollaries may be deduced from this equation:

6—The value of the adjustment depends on the weights of the cars used as a basis for the adjusted ratings.

7—The value of the adjustment depends on the values used for mechanical resistance in pounds per ton for the cars selected as a basis.

8—With given car weights and corresponding values of mechanical resistance, the adjustment decreases as the grade resistance in pounds per ton increases.

As previously explained, the sole cause of the difference in tons of any two trains of the same total resistance operated under similar conditions, is the difference in the mechanical resistance in pounds per ton for cars of unequal weight.

Grade and curve resistance in pounds per ton, however, are all independent of car weights, and therefore comparing these two trains of the same total resistance but of unequal weight, the difference in mechanical resistance in pounds per ton of the two trains, which causes the difference in the tons, decreases in relative value but not in actual value as the independent values of resistance increase an equal amount in pounds per ton for both cars or trains. As the adjustment represents the relative value of this difference in mechanical resistance in pounds per ton it follows that the adjustment will decrease as the sum of these independent units of resistance increase.

Therefore, the value of the adjustment depends on the car weights and on the values of mechanical, grade and curve resistance that are selected as a basis for the adjusted ratings. From this, then, it is clear that unless the adjustment represents in tons the relative difference in the total resistance in pounds per ton and in pounds per car, for the district to which it applies, it is safe to assume that the adjusted ratings are in error, and consequently motive power is underloaded or over-loaded.

Table VI shows how the adjustment varies with different rates of grade, the first entry involving mechanical resistance only and the other entries involving both mechanical and grade resistance. This table is further illustrated in detail by Exhibit E at the bottom of the page.

TABLE VI

ADJUSTMENT FOR VARIOUS GRADES

Grade	Tons per car: Lighter car	Tons per car: Heavier car	Difference in units of resistance: Mech. resist. per ton	Mech. resist. per car	Grade resist. per car	Total resist. per car	Adjustment
Formula	(W)	(W + w)	(e)	(r)	(d)	(r + d)	$\left(\frac{t}{c}\right)$
0.0.....	20	60	3.5	62	0	62	67.74
0.5.....	20	60	3.5	62	400	462	9.09
1.0.....	20	60	3.5	62	800	862	4.87

(To be continued)

Maximum Speed at Which Rated Tractive Force Can be Developed

By Edward L. Coster

IN the American Engineer for February, 1913, there was a paper by the late Lewis R. Pomeroy entitled Curves of Locomotive Operation, which contained formulas and constants for the determination of the maximum speed at which both saturated and superheated steam locomotives could develop their rated tractive force, and the corresponding coal consumption for different rates of evaporation per square foot of heating surface and per pound of coal.

A recent examination of this article revealed errors which led to a recalculation of the constants and their extension to include a higher degree of superheat. The revised analysis, which follows the previous method, is here presented.

Let d=cylinder diameter in inches.
s=piston stroke in inches.
D=driving wheel diameter in inches.
P=boiler pressure in pounds per square inch.
H.S.=total evaporative heating surface in square feet.
T.F.=rated tractive force in pounds.
w=weight of a cubic foot of steam at the assumed mean effective pressure=0.85P.
r.p.m.=revolutions per minute of driving wheels.
V=maximum speed in miles per hour at which a locomotive can deliver its rated tractive force.

Assuming that at full cut-off the volume of steam admitted to each cylinder per stroke equals the piston displacement, then the pounds of steam consumed per revolution

$$= \frac{4\ \frac{\pi}{4}\ d^2\ s}{1{,}728}\ w = 0.00182 d^2 s w.$$

This is based on the assumption that at full cut-off the

EXHIBIT "E"

COMPARISON OF TRAINS OF A GIVEN TOTAL RESISTANCE ON VARIOUS RATES OF GRADE—TOTAL MECHANICAL AND GRADE RESISTANCE 13,464 LB. SPEED 5 MILES PER HOUR

Items	Tons per car incl. cts.	Res. in lb. per ton: Mech	Grade	Total	Res. in lb. per car: Mech.	Grade	Total	No. of tons	No. of cars	Adjustment $\frac{t}{c}$
Straight and level track.....	20	6.8	...	6.8	136	...	136	1,980	99	
	60	3.3	...	3.3	198	...	198	4,080	68	
Difference	40	3.5	...	3.5	62	...	62	2,100	31	67.74
Grade 0.1 per cent.....	20	6.8	2.0	8.8	136	40	176	1,530	76.50	
	60	3.3	2.0	5.3	198	120	318	2,540	42.33	
Difference	40	3.5	...	3.5	62	80	142	1,010	34.17	29.58
Grade 0.2 per cent.....	20	6.8	4.0	10.8	136	80	216	1,247	62.35	
	60	3.3	4.0	7.3	198	240	438	1,844	30.73	
Difference	40	3.5	...	3.5	62	160	222	597	31.62	18.96
Grade 0.3 per cent.....	20	6.8	6.0	12.8	136	120	256	1,052	52.60	
	60	3.3	6.0	9.3	198	360	558	1,448	24.13	
Difference	40	3.5	...	3.5	62	240	302	396	28.47	13.90
Grade 0.4 per cent.....	20	6.8	8.0	14.8	136	160	296	910	45.50	
	60	3.3	8.0	11.3	198	480	678	1,191	19.85	
Difference	40	3.5	...	3.5	62	320	382	281	25.65	11.00

weight of steam furnished by the boiler per stroke to supply that lost by clearance, cylinder condensation, piston and valve leakage, is approximately equal to the difference between the weight of a volume of steam equal to the piston displacement and the weight corresponding to the volume of steam actually admitted to the cylinder per stroke.

Since for any speed, miles per hour

$$= \frac{\pi D \times 60 \text{ r.p.m.}}{12 \times 5{,}280} = \frac{D \times \text{r.p.m.}}{336},$$

$$\text{T.F.} \times V = \frac{0.85Pd^2s}{D} \times \frac{D \times \text{r.p.m.}}{336} = \frac{0.85Pd^2s \times \text{r.p.m.}}{336}.$$

$$\text{therefore} \quad \text{r.p.m.} = \frac{336V \times \text{T.F.}}{0.85Pd^2s},$$

hence the pounds of steam consumed per hour

$$= 0.00182d^2sw \times 60 \frac{336V \times \text{T.F.}}{0.85Pd^2s} = \frac{43.17V \times \text{T.F.} \times w}{P}.$$

If W lb. of water are evaporated per square foot the H.S. per hour,

$$\frac{43.17V \times \text{T.F.} \times w}{P} = \text{H.S.} \times W,$$

$$\text{whence} \quad V = \frac{PW \times \text{H.S.}}{43.17w \times \text{T.F.}} = c\frac{\text{H.S.}}{\text{T.F.}} \ldots\ldots\ldots\ldots (1)$$

$$\text{where} \quad c = \frac{PW}{43.17w} = 0.02316\frac{PW}{w}.$$

If P = 200 lb., m.e.p. = 0.85 × 200 = 170 lb., and according to Marks and Davis' steam tables, for saturated steam at this pressure, w = 0.4046 lb.; for 200 deg. F. of superheat, w = 0.3052 lb., and for 250 deg. F. of superheat, w = 0.2893 lb. Introducing these values in the last equation, and successively taking W = 8, 9, 10, 11 and 12 lb., we obtain the following values of c:

Evaporation of water per sq. ft. H.S.		Saturated steam.	Superheated 200 deg. F.	Superheated 250 deg. F.
8 lb.	c =	91.6	121.4	128.1
9 lb.	c =	103.0	136.6	144.1
10 lb.	c =	114.5	151.8	160.1
11 lb.	c =	125.9	167.0	176.1
12 lb.	c =	137.4	182.2	192.1

If W_1 lb. of water are evaporated per pound of coal, the maximum pounds of coal required per hour

$$= \frac{43.17V \times \text{T.F.} \times w}{PW_1} = c_1 \times \text{T.F.} \times V \ldots\ldots\ldots\ldots (2)$$

$$\text{where } c_1 = 43.17\frac{w}{PW_1}$$

Substituting the above values of P and w in the last equation, and successively taking W_1 = 7, 8, 9 and 10 lb., we derive the following values of c_1:

Evaporation of water per lb. coal.		Saturated steam.	Superheated 200 deg. F.	Superheated 250 deg. F.
7 lb.	c_1 =	0.01248	0.00941	0.00892
8 lb.	c_1 =	0.01091	0.00823	0.00780
9 lb.	c_1 =	0.00970	0.00732	0.00694
10 lb.	c_1 =	0.00873	0.00659	0.00624

As an illustration of the practical application of these formulas, consider two similar locomotives of 60,000 lb. rated tractive force, with 200 lb. boiler pressure, each having a ratio $\frac{\text{T.F.}}{\text{H.S.}} = 8$, or $\frac{\text{H.S.}}{\text{T.F.}} = \frac{1}{8}$, one engine using saturated steam, and the other steam superheated 200 deg. F. Then taking W = 10 lb., and W_1 = 8 lb., from equations (1) and (2) and the corresponding tables, we have:

For saturated steam, maximum speed, $V = \frac{114.5}{8} = 14.3$ m.p.h.

For superheated steam, maximum speed, $V = \frac{151.8}{8} = 19.0$ m.p.h.

For saturated steam, hourly coal consumption
= 0.01091 × 60,000 × 14.3 = 9,361 lb.

For superheated steam, hourly coal consumption
= 0.00823 × 60,000 × 19.0 = 9,382 lb.

These values of V closely agree with those shown by the corresponding curves of available tractive force given on pages 20, 21 of the 1920 edition of "Locomotive Data," published by the Baldwin Locomotive Works; and taken in connection with the figures for fuel consumption, clearly indicate the value of the 200 deg. F. of superheat.

The value of V can also be determined by the following simpler method. In his Notes on the Comparison of Locomotive Dimensions,* Lawford H. Fry says: "It may be taken that at slow speeds with engines in full gear, a horsepower can be developed (at the rim of the driving wheels) from 3.0 sq. ft. of heating surface in a saturated steam locomotive and from 2.5 sq. ft. in a superheated locomotive. On this basis the maximum speed in miles per hour at which the full rated tractive effort can be developed will be $V = \frac{125}{B}$ for saturated and $V = \frac{150}{B}$ for superheated locomotives,"

where $B = \frac{\text{T.F.}}{\text{H.S.}}$

Thus for saturated steam,

$$\text{A.H.P.} = \frac{5{,}280 \text{ T.F.} \times V}{60 \times 33{,}000} = \frac{\text{T.F.} \times V}{375} = \frac{\text{H.S.}}{3}$$

$$\text{Whence} \quad V = \frac{375}{3} \times \frac{\text{H.S.}}{\text{T.F.}} = \frac{125}{\frac{\text{T.F.}}{\text{H.S.}}} = \frac{125}{B}$$

Similarly for superheated steam,

$$V = \frac{375}{2.5} \times \frac{\text{H.S.}}{\text{T.F.}} = \frac{150}{\frac{\text{T.F.}}{\text{H.S.}}} = \frac{150}{B}$$

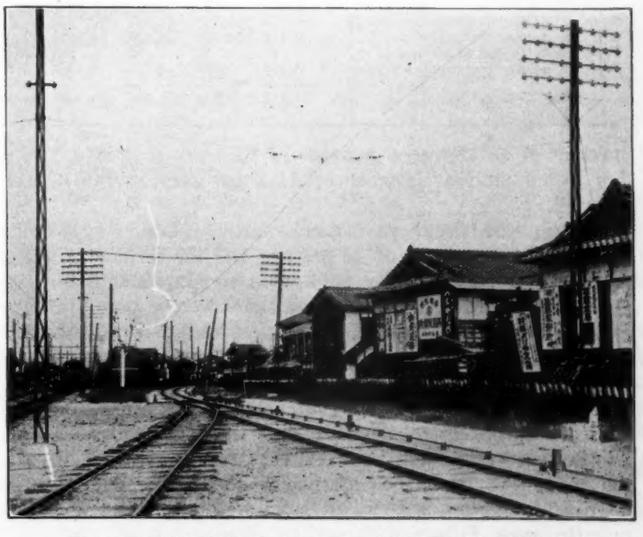
If B = 8, then for saturated steam, $V = \frac{125}{8} = 15.6$ m. p. h.

and for superheated steam, $V = \frac{150}{8} = 18.7$ m. p. h.

which values closely agree with those previously obtained. The formulas given in this paper being primarily based upon boiler capacity, disregard the gradual decrease in rated tractive force with increase of speed up to V due to the limitations of the valve gear, and the augmented machinery friction†, as indicated by the slight downward slope of the upper portions of the Baldwin tractive force curves above referred to.

* The *Railway Mechanical Engineer*, April, 1921, pages 211 to 215,

† See Kiesel's formula for machinery friction, given on page 57 of Wood's Locomotive Operation and Train Control, 1915.



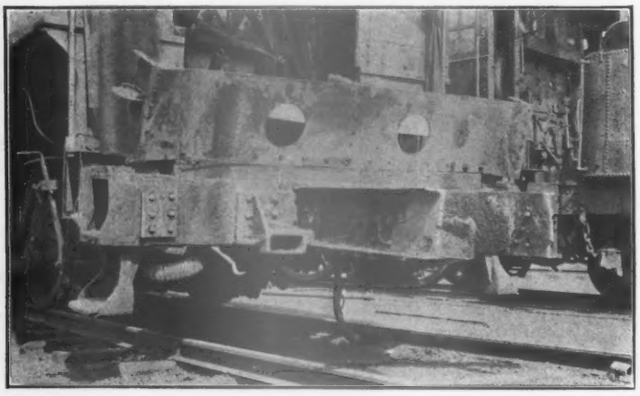
Electrified Section of Japanese Government Railways

Bureau of Locomotive Inspection Report

More Locomotives Inspected; A Smaller Number of Defects and 15 Per cent Fewer Accidents

THE eleventh annual report to the Interstate Commerce Commission of the chief inspector of the Bureau of Locomotive Inspection for the fiscal year ended June 30, 1922, shows an increasing number of locomotives inspected with a reduction in the number of defects and also a reduction in the number of accidents. A summary of the report follows:

The tables show the number of locomotives inspected, the number and percentage of those inspected found defective, and the number for which written notice for repairs was



Broken Sills Caused Locomotive and Tender to Separate—Lost Motion Previously Reported

issued because of not meeting the requirements of the law, with the total number of defects found and reported. They also show the number of accidents, with number of persons killed and injured, caused by the failure of some parts or appurtenance of the locomotive and tender, including the boiler and appurtenances thereof.

A summary of all accidents and casualties during the year ended June 30, 1922, as compared with the year ended June 30, 1921, shows a decrease of 15.4 per cent in the number of accidents, a decrease of 48.4 per cent in the number killed, and a decrease of 11.3 per cent in the number injured.

LOCOMOTIVES INSPECTED AND DEFECTS FOUND

	1922	1921	1920	1919	1918
Number of locomotives inspected...	64,354	60,812	49,471	59,772	41,611
Number found defective	30,978	30,207	25,529	34,557	22,196
Percentage found defective.....	48	50	52	58	53
Written notice for repairs served..	3,089	3,914	3,774	4,433	2,125
Total defects found.....	101,734	104,848	95,066	135,300	78,277

During the fiscal year there were 33 boiler explosions, resulting in the death of 22 persons and the serious injury of 56 others, a substantial reduction as compared with the preceding year. Most of these explosions were caused by overheating of the crown sheet, due to low water. Proper inspection and repair of all parts and appurtenances of the locomotive, including the boiler, is essential to safe and efficient operation, especially the firebox, water feeding and indicating appliances, together with thorough boiler washing as often as water conditions require, and the removal of scale and sediment from the interior of the boiler which cause heating surfaces to overheat, crack and weaken, and frequently cause failure with serious results.

Investigation of accidents during the year, where the fusion or autogenous welding process was involved supports the position previously taken that the process has not yet reached a state of perfection where it can be safely depended upon in boiler construction and repair where the strain to which the structure is subjected is not carried by other construction which conforms to the requirements of the law and rules, nor in firebox crown-sheet seams where over-heating and failure are liable to occur, nor its excessive use in repairing long and numerous cracks in side sheets.

ACCIDENTS CAUSED BY THE FAILURE OF SOME PART OR APPURTENANCE OF THE LOCOMOTIVE AND TENDER, INCLUDING THE BOILER

	1922	1921	1920	1919	1918
Number of accidents.....	622	735	843	565	641
Decrease from previous year (per cent)	15.4	12.8	[1]49.2	11.8	4.1
Number killed	33	64	66	57	46
Decrease from previous year (per cent)	48.4	3	[1]15.8	[1]23.9	25.8
Number injured	709	800	916	647	756
Decrease from previous year (per cent)	11.3	12.6	41.6	14.4	4.8

[1]Increase

Records continue to show that approximately 80 per cent of all autogenously welded seams involved in so-called "crown-sheet failures" have failed, while 16.9 per cent of riveted seams have failed under like conditions. The fatalities where sheets tore have been seven and one-half times as great as where they did not tear. From July 1, 1916, to June 30, 1922, autogenously welded seams were involved in 22.1 per cent of the crown-sheet failures, while 44.1 per cent of the total killed in crown-sheet accidents were killed where the autogenously welded seams were involved.

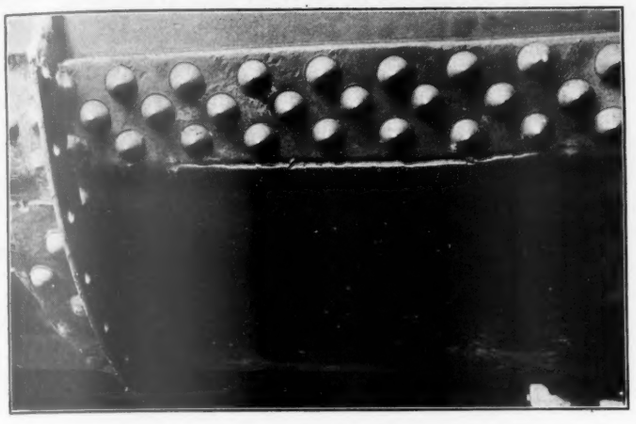
Exploded Main Reservoir; All Seams Autogenously Welded Four Years Before Explosion

ACCIDENTS CAUSED BY THE FAILURE OF SOME PART OR APPURTENANCE OF THE LOCOMOTIVE BOILER

	1922	1921	1915	1912
Number of accidents	273	342	424	856
Number killed	25	51	13	91
Number injured	318	379	467	1,005

A large number of accidents have been caused by defective grate-shaking apparatus, the majority due to the shaker bar

not properly fitting the fulcrum lever. This condition has been brought about because of no standard design being maintained, making such parts interchangeable. It should



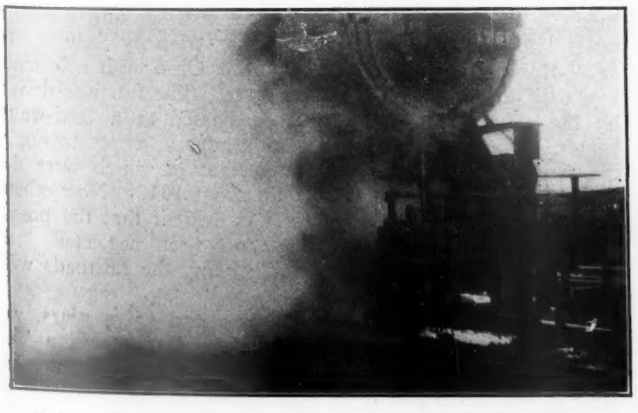
Rupture of Patch Applied to the First Course Longitudinal Seam in the Boiler Barrel

be required, therefore, that all carriers adopt a standard whereby shaker bars can be made interchangeable on all of their locomotives with a proper fit.

PERSONS KILLED AND INJURED, CLASSIFIED ACCORDING TO OCCUPATIONS

	1922		1921		1920		1919		1918	
	Killed	Injured	Killed	Injured	Killed	Injured	Killed	Injured	Killed	Injured
Members of train crews:										
Engineers	11	213	15	237	16	272	14	194	11	245
Firemen	10	277	25	360	20	404	22	265	19	306
Brakemen	7	66	13	64	9	77	11	82	6	62
Conductors	..	25	2	20	2	19	2	16	..	21
Switchmen	1	13	3	15	4	19	1	7	2	8
Roundhouse and shop employees:										
Boilermakers	1	10	1	7	2	9	1	9	..	11
Machinists	..	9	1	3	1	20	..	5	..	11
Foremen	..	1	1	3	..	3	..	3	1	4
Inspectors	..	2	..	5	..	1	..	6	4	4
Watchmen	..	3	..	4	4	3	..	2	..	3
Boilerwashers	..	1	..	7	..	13	..	7	1	4
Hostlers	..	10	..	8	..	13	..	6	..	8
Other roundhouse and shop employees	1	15	1	25	3	30	1	11	2	19
Other employees	2	23	2	16	4	26	3	23	..	26
Non-employees	..	41	..	26	1	7	2	11	..	24
Total	33	709	64	800	66	916	57	647	46	756

During the year 148 applications were filed for extension of time for removal of flues. Investigation disclosed that in



Ordered Removed from Service on Account of Steam Leakage

17 cases the condition of the locomotives was such that no extension could be properly granted. Fifteen were in such condition that the full extension requested could not be authorized, but an extension for a shorter period was allowed. Six extensions were granted after defects disclosed by the investigation had been repaired. Nine applications were withdrawn and the remaining 101 were granted.

There were filed 1,508 specification cards and 5,519 alteration reports necessary in determining the safe working pressure and other required data for the boilers represented. These specification cards and alteration reports have been

ACCIDENTS AND CASUALTIES RESULTING FROM FAILURES OF LOCOMOTIVES AND TENDERS AND THEIR APPURTENANCES

Part or appurtenance which caused accident	Year ended June 30— 1922 Accidents	1922 Killed	1922 Injured	1921 Accidents	1921 Killed	1921 Injured	1920 Accidents	1920 Killed	1920 Injured
Air reservoirs	3	..	3	1	..	1	2	1	2
Aprons	11	..	11	16	..	16	8	..	8
Arch tubes	4	..	5	5	..	5	9	1	15
Ash-pan blowers	7	..	7	5	..	5	6	1	5
Axles	5	..	17	5	..	6	5	..	5
Blow-off cocks	16	..	16	14	..	14	15	..	15
Boiler checks	4	..	4	7	1	7	5	..	6
Boiler explosions:									
A. Shell explosions	1	..	1	..	..	..	..	..	..
B. Crown sheet; low water; no contributory causes found	13	15	23	20	19	26	24	22	35
C. Crown sheet; low water; contributory causes or defects found	14	6	27	33	24	52	35	19	46
D. Fire box; defective stay bolts, crown stays, or sheets	5	1	5	1	2	..	2	..	2
E. Fire box; water foaming	..	..	..	..	..	..	..	..	..
Brakes and brake rigging	10	2	24	6	..	6	3	..	3
Couplers	21	..	23	11	1	13	8	..	8
Crank pins, collars, etc	10	..	10	6	3	8	4	..	4
Crossheads and guides	4	..	4	4	1	4	5	2	3
Cylinder cocks and rigging	3	..	3	4	..	4	..	..	..
Cylinder heads and steam chests	3	..	3	6	..	6	9	..	9
Dome caps	..	..	..	..	..	..	..	..	..
Draft appliances	6	..	9	8	..	9	1	..	1
Draw gear	7	..	7	8	1	8	11	2	9
Fire doors, levers, etc	2	..	2	8	..	..	11	..	11
Flues	28	..	32	32	1	35	45	..	52
Flue pockets	1	1	..	1	1	..	..	..	..
Footboards	11	1	10	8	3	5	23	..	23
Gauge cocks	2	..	2	..	..	..	2	..	2
Grease cups	3	..	3	7	..	7	10	..	10
Grate shakers	49	..	49	85	..	85	108	..	109
Handholds	12	1	11	19	..	20	15	1	14
Headlights and brackets	2	..	2	8	2	6	9	1	9
Injectors and connections (not including injector steam pipes)	21	..	24	15	2	13	23	..	27
Injector steam pipes	9	..	9	15	..	17	23	1	29
Lubricators and connections	9	..	9	12	..	12	14	..	15
Lubricator glasses	3	..	3	3	..	3	17	..	17
Patch bolts	..	..	..	..	..	..	..	..	..
Pistons and piston rods	6	..	6	3	..	3	3	1	3
Plugs, arch tube, and washout	12	1	19	15	..	18	28	..	40
Plugs in fire box sheets	2	..	3	2	..	2	1	..	2
Reversing gear	53	..	53	65	..	65	59	..	59
Rivets	..	..	..	4	..	5	..	..	..
Rods, main and side	23	..	27	18	..	21	16	2	20
Safety valves	..	..	..	..	..	..	..	..	..
Sanders	2	..	2	..	..	..	1	..	1
Side bearings	1	..	1	..	..	..	..	..	..
Springs and spring rigging	10	1	9	3	..	3	9	2	18
Squirt hose	54	..	54	82	..	82	82	..	82
Stay bolts	6	..	8	..	..	..	2	2	1
Steam piping and blowers	9	..	11	9	..	9	18	1	19
Steam valves	6	..	6	11	..	12	17	..	17
Studs	7	..	8	7	..	7	9	..	11
Superheater tubes	..	..	..	1	..	2	4	..	6
Throttle glands	1	..	1	..	..	..	3	..	4
Throttle leaking	3	1	2	3	..	3	1	1	..
Throttle rigging	5	..	5	1	..	1	6	..	6
Trucks, leading, trailing, or tender	11	2	25	6	..	8	1	3	1
Valve gear, eccentrics, and rods	18	..	18	10	..	10	6	..	6
Water bars	..	..	..	..	..	..	..	..	..
Water glasses	19	..	19	25	..	25	32	..	32
Water-glass fittings	6	..	6	2	..	2	4	..	4
Wheels	8	1	7	4	1	4	2	1	4
Miscellaneous	61	..	61	91	2	117	87	2	86
Total	622	33	709	735	64	800	843	66	916

carefully analyzed to determine whether or not the boilers covered were so constructed as to be in safe and proper condition for service, and that the stresses were within the limits required. Numerous discrepancies were found and corrective measures taken.

No formal appeal from the decision of any inspector was filed during the year, which again demonstrates that good judgment was exercised by them in the performance of their duties.

In closing the report the following recommendations, made last year, were repeated:

That the act of February 17, 1911, be amended to provide

for additional inspectors and increased compensation, and to provide for a sufficient appropriation adequately to carry out the purpose of the law.

That all locomotives not using oil for fuel have mechanically operated fire doors so constructed that they may be operated by pressure of the foot on a pedal or other suitable device located on the floor of the cab or tender at a proper distance from the fire door and convenient for the fireman.

That power-reversing gears be applied to all locomotives and that air-operated power-reversing gears have steam connections with the operating valves conveniently located in the locomotive cab, so arranged that in case of air failure steam may be quickly used to operate the reversing gears.

That a power grate shaker be applied to all coal-burning locomotives.

That all locomotives be provided with a bell so arranged and maintained that it may be operated from the engineer's cab by hand and by power.

That cabs of all locomotives not equipped with front door or windows of such size as to permit of easy exit have a suitable stirrup or other step and a horizontal handhold on each side approximately the full length of the cab, which will enable the enginemen to go from the cab to the running board in front of it, the distance between the step and handhold to be not less than 60 in. nor more than 72 in.

That all locomotives, where there is a difference between the readings of the gage cocks and water glass of two or more inches under any condition of service, be equipped with a suitable water column, to which shall be attached three gage cocks and one water glass, with not less than 6 in., preferably 8 in., clear reading, and one water glass with not less than 6 in., preferably 8 in., clear reading on the left side or back head of the boiler.

DERAILMENTS AND ACCIDENTS DUE TO DEFECTS IN OR FAILURE OF SOME PART OF THE LOCOMOTIVE OR TENDER

	1922	1921	1920	1919	1918
Number of derailments*	22	8	7	7	2
Number killed	5	..	7	6	..
Number injured	61	30	18	7	2

*Only derailments reported by carriers as being caused by defect in or failure of parts of the locomotives or tender were investigated or counted in this tabulation.

The Next Step in Locomotive Construction*

Present Steam Locomotive Needs to Make No Apologies—Suggestions As to Future Developments

By A. F. Stuebing
Managing Editor, *Railway Mechanical Engineer*

SO much has been said about the shortcomings of the steam locomotives as built at present that it is difficult to discuss the radically different types of motive power that are now being proposed without taking sides in the controversy and presenting a partisan viewpoint. From past discussion it is evident that the opinion prevails in some quarters that no determined effort is being made, or ever has been made, to improve the locomotive and that almost any radical change in the construction would be an improvement. Engineers in other fields seem to have little appreciation of the merit of the underlying principles that have made the standard type of steam locomotive for so long a time the best machine available for railroad motive power. On the other hand, men who have always been accustomed to the steam locomotive show a disposition to defend it under all conditions. I shall not try to present an argument but rather state a few of the important facts on both sides of the case and attempt to point out the relative merits of the various types from the standpoint of their economic value for passenger and freight transportation.

The locomotives used for main line service all over the world for practically 90 years embody three distinctive features—reciprocating pistons direct-connected to the driving wheels, a multi-tubular boiler of the fire-tube type and an exhaust nozzle for creating draft. It was the combination of these three features by Stephenson in 1829 that made the Rocket a success. Many people seem to consider the fact that there has been no change in these fundamental principles of locomotive construction in nearly a hundred years as evidence that the machine is out of date. I believe that further investigation would prove that it was rather a case of the survival of the fittest, for the history of the locomotive shows that there have been many attempts to improve it by radical changes in construction. The best locomotive designers in the country have always been on the alert to improve locomotive construction. Furthermore, the locomotive has a popular appeal to almost everyone and engineers in other fields have brought out many devices for application to the locomotive, some of which have been found to have real merit.

A Survival of the Fittest

To show that the present design of steam locomotive is not the result of the blind following of earlier precedents, let me cite a few examples. A great deal of attention is now being given to the substitution of a fan or blower for the exhaust nozzle as a means of creating draft. Trevethick first used the exhaust steam to increase the draft in 1807. Stephenson made a more successful application in 1829 and only six years later the first front-end fan was tried by Seguin. In 1839 Ross Winans of the Baltimore & Ohio built a locomotive with forced draft under the grate. The fan was driven by the exhaust steam which then passed to a feed-water heater. You are all familiar with later attempts to apply the same principle, the most important of which were the experiments made on the Santa Fe about 1912. Now others are working on the problem so it is evident that the possibilities of mechanical draft have not been neglected. As soon as it can show a substantial saving, the railroads will be found ready to accept it.

If we turn to the cylinders, valves and valve gears, we find the situation very similar. Consistent attention has been given to improving the efficiency of these parts. In fact, in the development of high steam pressures, which is one of the important means of decreasing fuel consumption, locomotives led the way for stationary power plants. Compounding also was given a thorough trial, but most compounds were abandoned because the increased maintenance cost and lack of reliability offset the saving of fuel. When

*From a paper entitled "Are We Due for a Radical Change in Locomotive Construction?" which was read at the January, 1923, meeting of the New York Railroad Club.

the Corliss valve gear was introduced, reducing the steam consumption of stationary engines, attempts were made to obtain the same benefit in locomotive valve motion but they were never successful because of the mechanical difficulties. If we turn to superheating, I believe we will find the modern locomotive represents the most advanced practice in the application of high superheat to reciprocating engines. The present tendency in engines for stationary service is toward the use of uniflow cylinders. These were applied on locomotives in this country many years ago and more modern designs are now in use in Great Britain and on the continent of Europe.

As long as the reciprocating steam engine was the only type of prime mover, the locomotive was always well up in the front rank of progress and it is only since the introduction of the steam turbine and the internal combustion engine that the efficiency of stationary power plants has shown any marked improvement over the locomotive. For years, engineers have studied the turbo-locomotive but until recently no one has been able to prepare a design that was suitable for railroad work. Nor has the internal combustion locomotive been neglected. Dr. Rudolph Diesel, the inventor of the Diesel engine and a very able engineer, tried to apply his internal combustion engine to a locomotive, but finally gave up because he found the problem so extremely complex and difficult. Many other examples could be cited of unsuccessful attempts to get away from the basic features of the steam locomotive but I believe those already mentioned are sufficient to indicate that the locomotive in its present form has survived because it has certain merits.

Fundamental Requirements

Perhaps the comments which I have already made sound like the conventional defense of the steam locomotive, but that is not my intention in presenting them. I merely want to give a historical background to show that some very able men have devoted their energies to designing substitutes for the steam locomotive without success. It is absolutely necessary to bear in mind that any new type of motive power, if it is to be a success, must be adapted to the existing railroad facilities. This means that it must haul a train load approximating that of the steam locomotive and make equal or greater speed. If the number of trains were to be increased to any considerable extent or the speed reduced by new motive power, the capacity of the lines would be reduced so that it would be necessary to provide additional track and larger terminals. This would involve an enormous capital expenditure which could not be justified by any conceivable increase in locomotive efficiency.

Any new type of motive power should be economical in the use of fuel, as simple and sturdy as possible, and what is perhaps most important, it must be reliable. One of the weaknesses and also one of the important advantages of the steam locomotive is the fact that there are very few defects that make it entirely inoperative. It may have leaks and pounds but it will usually bring the train in somehow. Very often this leads to neglect of maintenance which lowers the efficiency of the machine but under such conditions as existed during the strike this high degree of reliability is an invaluable asset, and it is a characteristic that is not found in other types of prime movers.

Fuel Economy and Locomotive Efficiency Not Synonymous

One of the common mistakes made by the critics of the steam locomotive is to consider that fuel economy and locomotive efficiency are synonymous. The locomotive must be considered as a transportation machine. From that viewpoint there are many factors besides fuel economy that determine whether it is economical or not. In 1921 the railroads spent $523,000,000 for locomotive fuel, but they also spent $529,000,000 for wages of engine and train crews and $448,000,000 for repairs to steam locomotives. Fixed charges on the investment in locomotives is also very important but is sometimes not given proper consideration because it is not listed in the operating expenses. These are only the major items which are directly affected by the locomotive. Many others are affected indirectly. It is evident that if a new type of motive power reduces the cost of fuel but at the same time causes a greater increase in the expenditures for crew's wages, repairs, fixed charges, etc., it is not an economical transportation machine regardless of its economy from the thermo-dynamic or mechanical standpoint.

Taking into consideration all the factors mentioned above, where can we look for a successor for the steam locomotive? Much, of course, will depend on changes in prices. If the relative cost of fuel becomes much higher, this will operate to the advantage of the types of motive power that are more efficiency from the fuel standpoint. If interest rates become very low the railroads may be justified in using equipment that involves a greater initial investment. However, in the present discussion changes in these relationships will be disregarded because it is impossible to predict how future conditions will affect them.

The Turbine Locomotive

There is no question but what we are justified in accepting the electric locomotive as a satisfactory substitute for the steam machine under certain special conditions. Universal electrification, however, seems to be a long way in the future and there is certain to be a big field for other types of motive power, namely, turbine and internal combustion locomotives, provided they can make good under railroad conditions.

Within the past three years, great progress has been made in the development of the turbine locomotive. Two fairly high-powered units have been built and a third is now under construction. It may be well to consider briefly some of the features of these turbine locomotives to see whether they conform to the requirements already laid down for an efficient transportation machine.

The first high-power turbine locomotive was that constructed by the Swiss Locomotive Works. It is a 10-wheel locomotive converted from the standard type which, of course, imposed many limitations on the design. Nevertheless, it is stated that on its trial trip the locomotive showed a fuel economy of 25 per cent as compared with a compound steam locomotive in similar service. The engine has not been free from mechanical difficulties and up to the present time the builders have not given out a complete description. It is understood, however, that the fan draft did not operate satisfactorily and certain parts of the machinery have failed.

Shortly after the Swiss turbine locomotive was built the Ljungstrom Turbine Company in Sweden finished a quite different design. The engineers of this company are recognized as among the foremost turbine designers and from the engineering and mechanical standpoint the locomotive leaves little to be desired. It has a thermal efficiency of 14.7 per cent, which would be considered a good performance for a large modern power house. In actual service on the Swedish State Railways, it saved 52 per cent of fuel compared with modern superheated reciprocating locomotives.

From the standpoint of capacity the locomotive does not show up so favorably, as it develops only 1,800 h.p. The designers state that machines with a capacity up to 6,000 h.p. could be produced, but I am inclined to doubt whether a condenser of the required size to give the proper vacuum under all temperature conditions could be built within practical limits of weight and size. The most serious handicap to the introduction of the turbine seems to be the mechanical complications which it involves. There are a great number of connections to be kept tight and the entire mechanism is

much more delicate than that of the reciprocating steam engine. This would tend to increase the difficulty of maintenance and reduce the proportion of the time which the locomotive would spend in actual service. The first cost of the turbine locomotive would be about three times that of the steam locomotive of equivalent power and its useful life is indeterminate so the fixed charges would probably be heavy.

I do not want to take the position of condemning the turbine locomotive for I feel very strongly that we should make a thorough test of all promising innovations and try in every way to utilize the meritorious features. I do believe, however, that in the present state of the art the turbine locomotive is hardly a practical unit for use on American railways and if it is to take an important place in future motive power it must be made more rugged and more simple.

An interesting modification of the geared turbine locomotive is the Ramsay turbo-electric locomotive recently placed in service in Great Britain. In this locomotive the turbine is connected direct to an electric generator, which, in turn, drives the motors on the axles. The electric transmission, of course, increases the cost and weight per unit of power very greatly and would limit the maximum output that could be obtained with locomotives of a given weight. Furthermore, the transmission would probably have a lower over-all efficiency than gear transmission. On the whole, it seems doubtful whether the additional complication over a geared turbine locomotive would be justified.

Diesel Locomotives

This leads us to the consideration of the application of the Diesel engine to locomotive service. It is a very attractive proposition because the Diesel engine has the highest thermodynamic efficiency of any prime mover developed up to this time. Its fuel consumption per horsepower is about one-fourth that of a modern superheated locomotive and because of the fact that there would be practically no standby losses the Diesel locomotive should use not more than one-sixth as much fuel as a steam locomotive. It also offers attractive possibilities of eliminating water and fuel stops and ash pit expenses and reducing the cost of hauling company coal and other fuel.

The two big problems in the application of the Diesel engine to locomotives are first to obtain a reasonable weight per unit of power and second to develop a practical method of starting the train. The Diesel engine, like the gas engine, will not start itself and will not deliver high torque at slow speeds.

The Diesel engine is similar to the gasoline engine except that the fuel is not ignited by a spark. The compression in the cylinders is carried up to about 500 lb. per sq. in. and the heat generated by compression is so high that when the heavy fuel oil is sprayed in under pressure, it immediately takes fire. The engine is usually started by compressed air from storage tanks which is admitted to some of the cylinders of the engine by a special valve arrangement. The individual units as built at present, range from 20 to 3,000 h.p.

The ordinary Diesel engine is heavy, some designs weighing as much as 450 lb. per horsepower, but special types have been built which are very much lighter. For instance the six-cylinder Diesel engine for the German submarines weighed only 57 lb. per horsepower. The 1,000 horsepower unit was 9 ft. high, about 4 ft. wide and 20 ft. long. If this Diesel engine was to be applied to a locomotive it would take up practically the entire space above the frames up to the limit of the vertical clearance. It would take three such engines to develop as much power as the locomotives that haul the Twentieth Century or the Broadway Limited.

I think we can pass over the problem of reducing the weight per horsepower of the Diesel as that seems to be practically solved at the present time, although the light-weight Diesels are more highly refined than the commercial types, and their cost is considerably greater. I do not think that is a very great obstacle, however. Assuming that it does not hinder the application, we still have the problem of making the Diesel engine develop power when the train is starting or running at low speed.

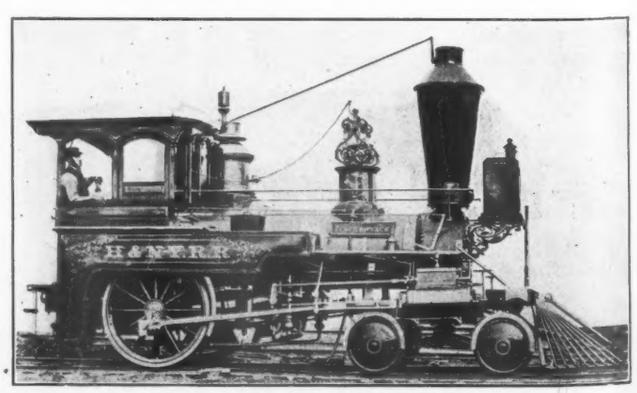
There are several means by which that can be effected. One is electric transmission, another is hydraulic transmission. Then we have also the possibility of auxiliary air to keep the engine running until the train is under way, and, last, the steam auxiliary.

The electric transmission is heavy and adds greatly to the cost of the unit. The hyradulic transmission is fairly efficient—it is light, but it is expensive, and all the designs that I have seen are difficult to build in large units. The air auxiliary has limited capacity. It is the system that was used on some Diesel locomotives built in Germany. A very large air tank was provided and not only furnished the air necessary to turn the engine over when starting it, but it also furnished power until the train had obtained such a speed that the Diesel engine was within its operative speed range. The lowest running speed as a rule is about one-tenth the maximum, so that an engine rated at 450 revolutions per minute would have a minimum speed of about 45 revolutions. This means, for example, that the Diesel engine if direct-connected could operate at train speeds from 4 to 40 miles an hour.

The steam auxiliary or the so-called Still Diesel engine is the latest development. In the Still engine the heat from the water jackets which surround the cylinders, and usually the exhaust as well, is utilized to generate steam in an auxiliary boiler. It would probably be necessary in locomotive service to supply considerable fuel to the auxiliary boiler, but it would offer the advantage of making steam available to act on the lower side of the pistons, so that the engine could be started and kept running for some time from this source of power. After the train was under way, it could be thrown over to operate as an ordinary Diesel engine.

Engineers are working very hard on the application of these various systems to the Diesel locomotive and there will probably be rapid progress in the development of improved designs.

The Diesel locomotive could effect remarkable savings in fuel and could be built in large units so that it should not increase the unit cost of crew's wages. The first cost would be high but this should be offset by the elimination of delays at ash pits and water stations. It is not unlikely that within the next few years a sturdy reliable Diesel locomotive will be developed which will be a worthy competitor of the steam locomotive.



Courtesy, Railway & Locomotive Historical Society

Hackensack & New York Railroad, 1860

This road is now a part of the New Jersey & New York, operated by the Erie. Locomotive built by Rogers Locomotive Works, Paterson, N. J.

Scrapping Steel Cars by Means of the Carbon Arc

Electric Cutting Process Proves an Economical Method for Reducing Scrap to Sizes That Can Be Cut by Shears

By E. H. Dralle
Westinghouse Electric & Manufacturing Company

THE electric arc has for some time been recognized as a most potent agent for the fabrication and production of mild steel structures, and as perhaps the most economical means obtainable for the repair of worn or broken steel members, especially where they are of appreciable thickness or volume; but as a means for reducing scrap material to convenient sizes for remelting, the value of the carbon arc has been only recently appreciated.

Perhaps the railroads, always among the first to exploit new welding developments and to experiment with new suggestions involving electric arc processes, stand to profit most by the widespread use of the electric arc as a means for scrapping steel coal and coke cars. In the past, it was a common practice among many railroads to turn worn-out cars over to wrecking companies for dismantling, but the possibility of using the carbon arc advantageously for this service is resulting in the discontinuance of this practice and the adoption of a plan whereby all wrecking of cars will be done within the railroad shops. This condition will, without a doubt, result in a saving of time and expense.

Various Methods of Dismantling

Assuming that the car wrecking is done within the railroad shops, the problem demands considerable study to determine the best method of dismantling; that is, there must be a choice among:

(1) Cutting the heads off the rivets, and dismantling in the reverse order of assembling.

(2) Reducing the cars to suitable scrap sizes, entirely by cutting with the carbon arc.

(3) Reducing to sizes suitable for handling by four men, and finishing the scrapping by means of a large shear or shears, whichever is required to meet conditions.

These methods will be considered in order without regard to any peculiar local conditions existing to influence the adoption of any particular method.

Selecting the Most Economical Method

It is probable that scrapping by cutting the heads off the rivets would be found desirable where parts of the car could be salvaged for use in the repair of other cars. In fact, it is in this service where rivet cutting is most widely applied. It is doubtful, however, if this would prove a profitable scheme of scrapping cars, even though employed to a great extent by wrecking companies.

To work entirely satisfactorily, all rivets that are to be cut should be in a plane closely approaching the vertical, so as to allow the molten metal a ready means of escape. Attempting to cut the heads off rivets in a horizontal plane will result in actually welding the plates to the rivets unless means are employed to force the metal from its position as rapidly as it is melted, as for example by using a strong current of compressed air. Such a procedure would be cumbersome in manipulation, and for this reason, objectionable. However, in vertical planes, this method of dismantling would compare favorably with straight cutting.

Time Required for Cutting Rivets

On an average coal car, there are approximately 1,400 rivets above the main frame of the car. With $\frac{7}{8}$ in. diameter rivets, and a current value of 800 amperes, it has been demonstrated that an average of 8 seconds actual cutting time is required per rivet. Obviously, then, the cutting time for a complete car would be 1,400 times 8, or slightly more than three hours. The discomfort caused by the use of these heavy current values makes it impossible for an operator to work continuously. This fact, coupled with the time consumed in moving from place to place will result in a working factor of perhaps 80 per cent, so that the cutting time is raised to $3 \div 0.80$, or $3\frac{3}{4}$ hours.

After the cutting is completed, one man with an air hammer; or two men, one with punch and the other with a heavy

hammer, must force out the stub ends of the rivets to complete the dismantling. This operation would require the greater portion of 1¼ hours, so that the time to dismantle a car down to the main framework is practically five hours.

The cost of scrapping a car by this method would be divided as follows:

Labor at 60 cents per hour—6¼ hours (5 hours for arc operator and 1¼ hours for helper to remove rivets)	$3.75
Power at 2 cents per kw. hr. (3 hours using 48 kw.-800 amp., 60 volts, from general efficiency of machine, 70 per cent)	4.20
Total cost, not including maintenance, interest on capital invested and depreciation of machine	$7.95

Adding to the above figure the cost for reducing the main framework of the car, would give a direct cost of about $15 for scrapping one car. The operating rates are not sufficiently fast to permit of one cutter scrapping two cars per day. To be practical, this schedule of two cars per day per cutter should be obtainable.

As pointed out, the above method is applicable where it is desired to salvage parts for rebuilding into other cars. Where cars are in such bad condition as not to warrant the saving of parts, best results are obtainable by using the straight cutting method to reduce to sizes suitable for handling by four men, especially since the cost of dismantling will be less than $10 per car as compared to $15 for the rivet cutting method.

To arrive at a figure upon which to base a cost for scrapping cars, a test, as will later be described, was conducted, and an accurate record kept of all results. The car was a standard coke car, having solid metal bottom, ends and half sides, the upper halves of the sides being of expanded metal.

Scrapping by Cutting Through Sheets and Frame

Starting at one of the four upper corners, immediately below the top supporting angle—this being left intact to make sure that the side would not fall out until the desired time—

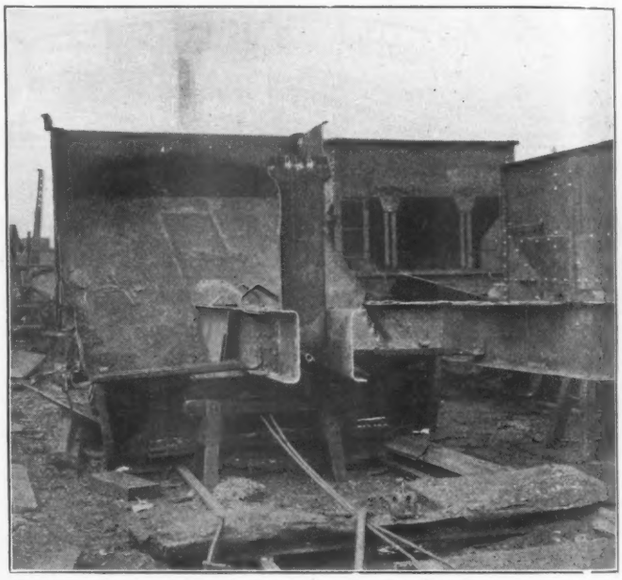
Operator Cutting Through the Sides of a Car; the Cut Will Be Continued Straight Across the Bottom and Up the Opposite Side to Remove the End of the Car

the cut was made down the corner to the floor of the car, thence along the entire length of the side, directly above the floor, and up to the other corner. The top angle-iron supports were then cut at the corners, and the side allowed to drop down. The time consumed was 51 minutes, and the distance cut was 43½ ft. The original thickness of material was ¼ in. sheet, but paint and rust in some places made the equivalent thickness in terms of clean iron sheets greater than ¼ in. On the other hand, corrosion was so effective as to reduce the equivalent thickness below ¼ in. in many places. One-fourth inch, however, can be taken as an average value for the thickness of material cut. It should be remembered that on account of the paint and scale on this iron, cutting conditions are entirely different from those experienced with cutting clean iron sheets.

As soon as the car side was dropped to the ground, it was cut up into three equal pieces by making two cuts along lines parallel to, and equidistant from the ends. Each cut was through 2½ ft. of ¼ in. solid material, requiring two minutes cutting time, and 3 ft. of expanded metal requiring 30 seconds cutting time.

A similar procedure was used on the second side of the car, which was cut into the same number of pieces as the first side.

At each end of the car the car bottom sloped at an angle of approximately 45 deg. from the frame to within 3 ft. of the top of the car. The length of this sloping sheet is approximately 6½ ft. After cutting out both sides of the car, cuts were made across the car along the line described by the intersection of the sloping bottom sheets and the bottom of the car. This cutting, too, was through material ¼ in. in thickness. The length of cut was 9 ft. on each end, and the time of cutting seven minutes.



Center Sill Cut Through After Side Sheets and Side Frame Have Been Removed

After cutting the ends as above described, it remained to cut four upright, 3 in. by 3 in. angles, and one 2 in. by 2 in. angle, all ¼ in. thick, directly above the car frame, to allow the ends to fall to the ground. The time required for this operation was seven minutes on one end, and four minutes on the other, the difference in the two times being due to the brake mechanism which had to be cut on the end requiring the greater time.

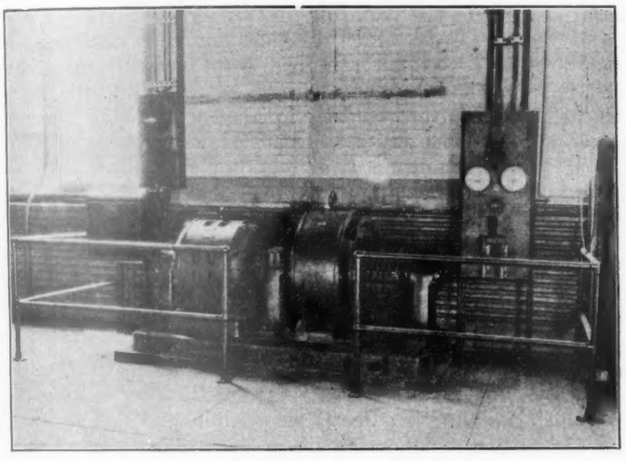
With the operations thus far, the car had been cut into eight pieces, three pieces on each side, and each end constituting one piece. To further facilitate handling, a cut was made the entire length of the car, parallel and adjacent to the center sill, and then two cuts were made across the bottom, directly back of each bolster. The lengthwise cut, 20 ft. long, required 40 minutes, and the cross cuts, each in effect being equivalent to 12 ft. of cutting, required 20 minutes each, or a total of 40 minutes. The greater portion of this time in making the crosswise cuts on the bottom was consumed in making the cuts through the center sill. The vertical members of the center sill together with the side frames, which approximated almost one foot in depth, account for the 12 ft. of cutting across the bottom of the car, which is only 9 ft. wide. In making the lengthwise cut, it was also

necessary to cut through two heavy channel door supports.

With the operations as described for cutting up the main frame and bottom of the car, it will be seen that the total number of pieces into which the car was cut was 14. Of course the whole truck on each end remained intact, but the cutting was done in such a way that the framework could be entirely removed from the trucks.

The object in cutting the material to sizes suitable for handling by four men, is in keeping with the scheme to have a large shear or shears to which these larger parts will be carried by the men for cutting up into pieces suitable for remelting.

It is possible for four men to handle the side and end pieces as cut, but on account of the heavy framework and material in the bottom of the cars, additional cuts are necessitated to facilitate handling. It will be found advantageous and economical to reduce these heavy parts to suitable sizes for remelting, without transporting them to the shears. The cutting could be done completely by the carbon arc.



Motor-Generator Set of 1,000 Amperes Capacity Used for Arc Welding and Cutting

To more clearly show the cuts which were made on the car, the number of feet for each cut, and the total time for cutting, Table I has been prepared.

TABLE I—DETAILS OF CUTTING WITH CARBON ARC IN SCRAPPING STEEL CAR BODY

Location of cut	Material cut	Length of cut, feet	Number of cuts	Time per cut, min.	Total feet cut	Total time, min.
Lengthwise—side	¼ in. sheet	43.5	2	51	87	102
Crosswise cuts on side sheets	¼ in. sheet	2.5	4	2	10	8
	exp. metal	3	4	½	12	2
Ends at intersection of bottom and sloping bottom sheets	¼ in. sheet	9	2	7	18	14
*Upright angles on each end	5—3 in. by 3 in. by ¼ in. angle.	½	11	1	6	11
Cross cuts on bottom	¼ in. sheet and channels	12	2	20	24	40
Lengthwise cut on bottom,	¼ in. sheets and angles	20	1	40	20	40
Total					177	217

*For purposes of calculation, the angles on each end were taken as 3 in. by 3 in., and five counted on each end. One end had the brake mechanism mounted on it, which required practically three minutes' time to cut, making seven minutes' cutting time on one end, and four minutes on the other.

From the above table, the following costs were obtained:

Total number of feet cut (equivalent of ¼ in. sheet)	177 ft.
Actual cutting time in hours	3.61
Kw. hours consumed (850 amp., 60 V., M. G. set eff. 80 per cent 64 kw. for 3.6 hours)	230
Cost of labor at 60 cents per hour	$2.16
*Cost of power—2 cents per kw. hour	4.60
Total	$6.76

*Two cents per kw. hour for power is only a basic figure. This should be much smaller if power is bought in large quantities, or if the customer generates his own power.

Assuming that the operator's time is eight hours per car instead of less than four, as shown for the actual cutting time, the cost per car will still be less than $10, because only the item of the operator's time changes, the actual cutting time being the same whether the operator spends a full day on the car or a half day. To be perfectly exact, the power bill will slightly increase, because the losses of the set go on as long as the set is running.

To have one man (cutter) completely wreck a car for cutting into sizes suitable for remelting, would result in greater expense, since a shear can reduce the smaller pieces at a more rapid rate than can be done with the arc, and the four men employed to carry material to and from the shears could be utilized by several cutters. Some few men would necessarily be employed for loading the scrap, and a few additional could be used to advantage to assist in carrying material to and from the shears.

The cost of shears, interest on investment, and depreciation of the machinery must also be considered in this connection, but unquestionably these items can be more than favorably balanced against the extra cost of operators and machines to supply them in order to do equal amounts of work per day.

Any one of the proposed methods of scrapping cars with the carbon arc will result in a great saving over the cost to do the same work with the acetylene torch. Paint, scale, and oxides which give way rapidly under the intense heat of an electric arc, are obstacles of no small importance when cutting with the acetylene. Furthermore, the cost of gas is one of the greatest items of expense, inasmuch as the torch is usually allowed to burn regardless of whether cutting is being done or not. With the electric arc, power consumption ceases when the operator fails to maintain an arc.

Aside from the cost of doing the work with gas, the inconvenience of hauling tanks, both empty and filled, to and from supply points, makes the electric arc (where power is always at the operator's command) stand out by far the more favorable of the two processes.

Equipment Required for Electric Cutting

The electric equipment required for supplying power to the carbon arc consists simply of a motor-generator set and the necessary moto-generator control and cutting panel. A desirable form of machine is shown in the illustration. The set comprises a suitable motor, either A. C. or D. C., driving a low voltage compound wound D. C. generator. The generator is controlled entirely by a panel mounting a circuit breaker, ammeter, volt meter, and knife switch, as shown.

In addition to the above equipment, there are required only a suitable mask, electrodes and holders, and a cutting resistor for each operator.

The cutting resistance is comprised of four frames of resistance mounted in an angle iron framework, having overall dimensions approximately 48 in. long, 35 in. wide, and 17 in. high. This complete unit is mounted on a trolley which allows the resistor to be moved along the car as cutting progresses. This feature eliminates a long electrode holder cable. The entire carriage can be easily moved along the trolley track by simply pulling on the properly secured electrode holder cable. On the front of the resistor unit is mounted a slate, 15 in. by 13 in. by 1 in. thick, having mounted on it two 200-ampere, single-pole, single-throw knife switches. These knife switches control resistance steps of such value that current values of 400, 600 and 800 amperes may be obtained for cutting service. The 400 ampere resistance step is permanently in the circuit, and each of the knife switches controls one 200 ampere step.

Plant layout is an important feature in the successful use of the arc process for scrapping steel cars, and while local conditions will largely determine the nature of each installation, experience has shown that best results are obtainable

with a layout such as described in the following paragraphs.

It is preferable to have a separate building for this cutting service. The building should be divided into booths, accommodating one car each, and should be so designed that the motor-generator set, or sets, supplying power will be centrally located with respect to the arc cutters, power for which will be conducted along an overhead trolley. On this trolley, mounted on a carriage as described above, is the cutting control resistor with cable and electrode holder attached. The power for all operators is conducted through the trolley circuit, but each operator has his own cutting resistance, and can use any current value suitable for the work which he is doing. This arrangement of the power circuit positively insures non-interference among operators, regardless of how many are operating from the circuit. By having the resistance on a movable trolley directly above the operator, maximum cutting rates are obtained, since the movement of cables and holders to the most inaccessible positions on the car, is accomplished with minimum time and effort.

The object in having separate booths for each car is to protect operators from injurious reflected rays, and often, perhaps, direct rays from adjacent arcs. As a safety precaution, it is desirable to have only one operator per car, although with a properly outlined system of dismantling, it would be entirely possible to use two operators per car.

While the work done thus far on dismantling cars by the carbon arc process has shown that this method is decidedly superior to other methods of scrapping, it is entirely possible that a more widespread use of this process will result in new and improved means for wrecking cars, which will still further decrease the already low cost of dismantling by the arc process.

Recent Decisions of the Arbitration Committee

(*The Arbitration Committee of the A.R.A. Mechanical Division is called upon to render decisions on a large number of questions and controversies which are submitted from time to time. As these matters are of interest not only to railroad officers but also to car inspectors and others, the Railway Mechanical Engineer will print abstracts of decisions as rendered.*)

What Constitutes Collision Under Rule 32

Nashville, Chattanooga & St. Louis empty box car No. 4217 had six wood sills and several other parts broken in a Detroit, Toledo & Ironton train on May 23, 1921. The train, which was made up of about 75 cars, broke in two about 15 cars from the head end and the damage to car No. 4217 occurred when the rear end of the train ran into the head end following the automatic application of the brakes. Neither this car nor any other cars in the train at the time were derailed, cornered or side-swiped. Joint inspection disclosed that the six broken longitudinal sills were decayed, as was also the body bolster and end sill, which were broken at the same time. The handling line maintains that the damage was the direct result of the weakened condition of the car, citing case No. 1165 as parallel, and that the settlement should be handled under Rule 120. The car owner maintained that the case comes under item (d), Rule 32, which exempts from owner's responsibility damage caused by collision. Case 1179 was cited as parallel, except that in that case the car was subjected to derailment, while Nashville, Chattanooga & St. Louis car No. 4217 was involved in a collision. The owner maintained that the settlement should be made under the provisions of Rule 112.

The decision of the Arbitration Committee states that: "There is no evidence of the car having been subjected to any of the unfair conditions referred to in Rule 32. The car owner is responsible."—*Case No.* 1241, *Detroit, Toledo & Ironton vs. Nashville, Chattanooga & St. Louis.*

Break-in-Two Not Evidence of Handling Line Responsibility Under Rule 32

On December 20, 1920, Pence automobile car No. 595 was broken in two while being moved by the Chicago, St. Paul, Minneapolis & Omaha in a train consisting of 9 loaded and 43 empty cars. While the train was moving at a speed claimed to be about four miles an hour, with one engine at the head end and one engine at the rear end, a coupler knuckle slipped by on the second car from the head engine. The resulting emergency application of the brakes caused the Pence car, which was the fifth forward from the rear end, to break in two. The handling line set forth that the car was an old gondola from which the sides and ends had been removed, that it was not equipped with inverted truss rods and therefore had only the strength of the wood sills, in a generally weakened condition, to prevent breaking upward under impact. The owner was notified, as provided in Rule 43, as to the circumstances surrounding the failure, and on February 22, 1921, authorized the handling line to make repairs and render bill for the expense. After the bill was rendered the owner refused payment, claiming that the handling line was responsible under Rule 32 and protesting that the car was not worth what had been charged for repairs. This company maintained that had there been no pusher engine at the rear end of the train, the accident would not have occurred. The handling line contended that the cause of the accident was not one of those specified under Rule 32, for which the handling line is responsible, and that in making and billing for these repairs it had fully complied with the rules.

In sustaining the bill of the railroad company against the car owner, the Arbitration Committee stated: "Car was not damaged under any of the conditions enumerated in Rule 32. Rule 43 was complied with in obtaining owner's authority before repairs were made."—*Case No.* 1243, *Pence Automobile Company vs. Chicago, St. Paul, Minneapolis & Omaha.*

Do Unit Charges for Bolt Renewals in Passenger Rule 21 Include Jacking?

In rendering bills for the replacement of broken or missing draft bolts on Northern Pacific passenger cars, which required that the car be raised, the Southern Pacific charged for the actual time required to complete the operation. The Northern Pacific took exception to this practice, citing specifically Southern Pacific's bill No. 374108 for such repairs made during October, 1920. The exception was taken on the ground that item (7) of passenger Rule 21 (for bolts over six inches in length) covers this work and that the charge of 0.4 hours specified in Supplement No. 3 of the 1919 code, which was effective at the time, is ample allowance to cover all labor necessary to apply them, including jacking up the car. The Southern Pacific contended that items (6) and (7) of passenger Rule 21 do not cover renewal of any bolts which require jacking of the car but refers solely to bolts which may be applied in the ordinary course of repair work without the necessity of jacking the car or other preparation. In support of this view the Southern Pacific called attention to the fact that under the freight car rules the labor charge for jacking alone is 1.5 hours. For these reasons the Southern Pacific maintained that the note following item (26) of passenger Rule 21, Supplement No. 3, applies in this case.

The Arbitration Committee decided as follows: "The labor charges in question are not excessive. Objection of the Northern Pacific is not sustained."—*Case No.* 1242, *Northern Pacific vs. Southern Pacific.*

Present Day Tendencies in Car Construction*

Recent Improvements in Design; Need of Rust-Resisting Steel, Improved Insulation and Painting

By E. R. Viberg
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THE title of this paper would lead one to believe that today's tendencies in car construction differ to a great extent from construction in the past, but this is not the case. Those in charge of designing and building equipment in the early days of railroading had the same object in view as prevails today, namely, to improve and strengthen the rolling stock to meet the ever-increasing demand from the transportation department for stronger and heavier capacity cars, and at the same time having in mind a reduction in dead weight in proportion to the revenue load.

In order to form some idea regarding this important subject and the difficulties encountered, it may be interesting to first review the early history of the car-building industry.

Development of Passenger Cars

There was little difference in appearance between the early passenger car and the freight caboose. Some attempts at ornamentation were made, but these were modest, consisting simply of ornamental paintings, scenes from life more or less artistically executed, and very simple arrangements for comfort.

Candle light was provided for night travelers, and in cold weather a stove in the corner of the car furnished the heat which travelers had been accustomed to draw from each other, or in a small degree, from the straw with which the car floor had been covered.

As travel increased and the necessity for better accommodation became apparent, the car was lengthened and its height increased, ventilation was improved and sanitary conveniences added.

A great step forward was taken when provision was made for sleeping in a recumbent posture. A night car with rude sleeping berths such as used on steamboats, but not furnished with bedding, was the first form of sleeping car which surprised and delighted the public. This car was introduced on the Cumberland Valley in Pennsylvania in 1836, and in November, 1838, the Philadelphia, Wilmington and Baltimore put on a similar car.

In 1854 sleeping cars having the same general features as those now in use were introduced. These cars provided seats for about 60 passengers, and at night these seats were converted into flat berths. The inventor was Theodor T. Woodruff. The license to build and operate these cars was later acquired by Webster Wagner.

Pullman sleeping cars were introduced in 1864 and 1865. In 1867 a hotel car, the first in use, was built by him for the Great Western of Canada, which road in August, 1882, was absorbed by the Grand Trunk. In 1868 Wagner built the first two drawing-room cars ever run for pay.

For supplying heat, improvement in processes to the number of several hundred have been patented. Heating by salt water circulation once displaced the use of stoves but afterwards steam heating was substituted, and most cars constructed today are equipped with a heating system which takes steam from the locomotive.

In lighting, several forms of compressed gas have been substituted for candles and oil lamps. All cars now built are generally equipped with electric lighting.

*From a paper presented before the Canadian Railway Club, December 12, 1922.

Freight Car Development

The introduction of steel rails led to the construction of heavier freight cars, for it was soon found that such rails would bear heavier loads without danger. By increasing the dead weight of the car from say 18,000 lb. to 21,000 lb. its carrying capacity was increased from 20,000 lb. to 30,000 lb., etc. The carrying capacity can be increased faster than the dead weight of the car, and thus the paying weight constitutes a larger percentage of the total load hauled.

The construction of wooden cars of a greater capacity than 70,000 or 80,000 lb. not being practical because the increase in size and weight of parts would increase unduly the dead weight and decrease the revenue load, together with the increased cost and scarcity of suitable lumber, steel freight cars were introduced in 1897.

The following table of averages shows the relative increase since 1876 in dead weight of cars and revenue load:

Year	Dead wt. of car	Wt. of rev. load	Total wt. loaded	Wt. of car, percentage of total	Rev. load, percentage of total
1876	20,500 lb.	20,000 lb.	40,500 lb.	50.60	49.40
1882	24,000 lb.	40,000 lb.	64,000 lb.	37.50	62.50
1889	27,700 lb.	60,000 lb.	87,700 lb.	31.60	68.40
1895	36,000 lb.	80,000 lb.	116,000 lb.	31.04	68.96
1920	48,300 lb.	120,700 lb.	169,000 lb.	28.53	71.47
1921	78,900 lb.	236,100 lb.	315,000 lb.	25.04	74.96

This table is interesting, as, while it shows 285 per cent increase in dead weight of present day equipment over the earlier type, it shows also that the earning capacity has been increased by 1080 per cent over the old and small car used in the early days of railroading, illustrating the great strides made in car construction since 1876.

Improved Passenger Car Construction

In a general way today's tendencies in car construction consist mostly in improvement of present designs and may be summed up as follows:—

1st. To improve the present construction.
2nd. To eliminate parts.
3rd. To lighten equipment.
4th. To reduce friction.
5th. To use commercial run of steel.
6th. To use rust resisting material.
7th. To improve insulation.
8th. Standardization of component parts.
9th. To preserve the equipment by improved painting.

Among these I shall deal with the various branches of construction and details.

The principal efforts of builders in conjunction with various railroad officials have been to improve underframe and draft gear conditions and details in connection with protection and safety of passengers, with greater comforts for travelers. One detail, however, until recently did not receive the attention it should; this important part is the coupler. During the development of car bodies and trucks, various parts were strengthened and heavy capacity friction draft gear and buffer applied, but the coupler remained much the same, with the result that coupler failures were frequent. The 5 in. by 5 in. long shank coupler with the old type head, used for so many years for passenger cars, will soon be obsolete, however, as cars now built are all equipped with

class "D" A.R.A. standard couplers, with shank of proportionate strength to the head.

The adoption of this coupler, and increase of the present inadequate coupler side clearance, has made it necessary to arrange for the air, signal and steam pipes to oscillate with the coupler to prevent tearing of hose connections. This may be accomplished by a special design of combination coupler and pipe carrier, or simply a separate pipe carrier which will work with the coupler and maintain a fixed relation between coupler shank and pipe connections.

As wood body construction for passenger cars has disappeared, so also the composite wood passenger trucks have become obsolete and are being replaced by cast-steel trucks. These trucks eliminate about 50 per cent of the parts necessary for the wood trucks and afford better facilities for application of clasp brakes, the tendency now being to equip all passenger trucks, both four and six-wheel, with this type of brake rigging.

Present tendencies indicate that not only center sills and draft gear are being given due consideration, but all parts entering into construction of cars are carefully analyzed for strength consistent with dead weight. Furthermore, making all parts possible interchangeable eliminates a great number of otherwise necessary parts, and results in effective and economical construction.

Platforms have been strengthened to prevent telescoping, and the old built-up construction with its multiplicity of parts, more or less discarded for the one-piece cast-steel buffer casting, to which center sills and other members are joined. These castings are generally so designed that all attachments such as safety chains, buffer and draft gear, can be readily applied and easily detached in case of repairs.

Underframes of various types have been used, but the majority of cars now built are equipped with fish-belly type center sills. Care must be exercised in designing center sills, keeping the resultant line of force due to draft gear and buffer end shocks located on the center line of gravity of section, or below if possible, so that combined working stresses in compression and tension members will not exceed the elastic limit of the material. This can readily be accomplished with center sills of rolled channel sections; that is, center sills having a uniform depth throughout, but this type is not extensively used on account of its weight and deflection except for short cars. Fish-belly type center sills seem to be preferable for all cars of extreme length, and with this type the features mentioned above must be carefully analyzed and provided for by the proper distribution of the various sections.

The superstructure has been changed considerably in recent years. One of the most radical departures was the elimination of outside and inside gothic sashes, vestibule end windows and upper deck sashes. The elimination of gothic sashes effected economy in construction and incidentally removed numerous places for air leakage and draught, also facilitating a more sanitary construction as it was impossible to keep the art glass clean. The upper sashes were replaced by exhaust ventilators, with an improvement in ventilation and economy in construction, as well as improving the appearance of the interior of the car.

Attempts have lately been made to eliminate as many pressed steel parts as consistent with economy, and some designs have been prepared having rolled angles for side posts, instead of pressed steel shapes. This is an advantage as it overcomes to a great extent variation in the structure which it is impossible to eliminate entirely when using pressed steel parts. The angle post also affords better facilities for attaching furrings for the inside finish, if wood is used, and most cars built in this country on account of climatic conditions are so fitted.

Some years ago a law was passed compelling railroads to equip all cars for interchange with automatic couplers, this primarily to prevent accidents when coupling cars. Little progress has been made, however, towards also automatically coupling the air and steam connections. Many devices have been tried but have not given entire satisfaction; but developments are still progressing, and I believe railways would be justified in applying some devices now on the market, which, while not perfect, would be a great aid in speeding the making up of trains, and preventing accidents, and would, consequently, effect a great saving to the railroads.

Reduction of Dead Weight

Before the dead weight of cars can be reduced—having in mind present capacities, corrosions, loads and shocks—a grade of material having higher elastic limits and ultimate strength will be necessary, or an alloy steel of a lower specific gravity, of equal strength in pounds per square inch, and same elasticity, as material used at the present time. To lighten equipment by using higher fiber stresses will not result in a satisfactory solution, as stresses produced in service, based on assumed loading and buffing shocks, are as high as it is possible to employ without producing fiber stresses in excess of the elastic limit. It is evident from some cars built only a few years ago, now under repair, that material has been subjected to stresses in excess of its physical limits.

Reduction of dead weight of equipment is important from so many points that it merits exhaustive investigation. Assume the use of steel having an ultimate fiber stress of 100,000 lb. per square inch, and a factor of safety of three; this would allow a working stress of 33,000 lb. per square inch, or an increase of 100 per cent over safe fiber stress with present material. This would revolutionize designs prevailing today and effect a great saving in weight.

Roller Bearings

Journal boxes equipped with roller bearings are commencing to make their appearance in steam railroad equipment. A few years ago the Grand Trunk had a number of cars so equipped. The importance of reducing friction is now being seriously considered by many railroads and roller bearings are being tested in the States. While it may be a little premature to judge of their merits I venture to say that before long they will become standard for passenger cars.

Tests covering a number of years have proven that roller bearings will save from 10 per cent to 15 per cent in power consumption, and effect a saving in coal of 10 per cent, which is an item worth considering, particularly as the coal becomes more expensive. Roller bearings for railway equipment while new in this country have been used for a number of years in Europe for both freight and passenger equipment and have now been adopted in some countries as standard.

Commercial Steel

When steel was first introduced for passenger cars it was the general opinion that it would be necessary to make the exterior of the same appearance as the wood car, namely, to conceal the rivets by applying mouldings over the rivet heads and to obtain a perfectly flat surface expensive cold-rolled-steel sheets were employed.

The present practice, however, is to make the steel car of an appearance that will convince the public that they are traveling in a car of steel construction which will afford better protection in case of collision. Instead of high priced cold rolled steel sheets, commercial run of steel is being used in passenger car construction, and may be referred to as follows:

1. It is useless to pay excess cost for special rolled steel sheets, when in applying they are almost certain to become distorted.

2. As a general proposition it is a case of taking such a quality as the mills supply.

3. It may sometimes be advantageous to pay the extra

cost for special processes such as "patent levelling," but in this case only sheets in about 12 ft. lengths can be obtained.

Since commencing the building of steel passenger cars on a commercial basis, we have been confronted with the question of obtaining flat sheets. These could be readily obtained when using sheets of heavy gage, but cars in recent years have been built with light gage sheets in order to reduce dead weight, and this has resulted in buckles appearing in the completed structure which unquestionably is objectionable but difficult to overcome. Buckles are also caused by car framing such as side-sills, belt-rails, posts, and other members in contact with the sheets not being absolutely true and in perfect alinement, and in consequence will appear in the sheets after riveting. Also upon removal of the supporting stands used during riveting up, buckles will appear in the sheets due to the natural deflection of the car structure from its own weight, and may be explained with the following remarks:

The appearance must be as good as it is economically practical to produce, without sacrificing strength. Formerly it used to be the practice to doll up the exterior, and also the interior with gold and other decorations but today's tendency is to make the cars of a plain, sanitary, comfortable design. It has often occurred to the writer that the railroads would be justified in spending less money for their equipment, as I have observed many times during my travels, from the abuse of equipment by the public, that they either do not care, or have no idea of the expense of such equipment.

Rust Resisting Material

The steel car has undoubtedly proven superior to the all-wood car in many important respects, but here instead of decayed lumber we have another evil—corrosion, which constantly works on the structure until it is unsafe or not able to stand the loads and shocks incident to the service. Therefore, the tendency today is to specify copper bearing steel to overcome to some extent excessive deterioration, and some roads now specify all sheets and plates ⅛ in. thick and over to be of this material, and I understand that other roads specify this material for rolled shapes as well as for plates for passenger cars.

This material is also specified by many roads in the States for freight cars, and particularly for parts which come in contact with the lading. It takes an extra above standard base price of ordinary O. H. steel of similar sizes and shapes but this is negligible if final result expected can be obtained, as the extra cost of copper bearing steel would only amount to 1½ per cent of the total cost of the new car at present prices.

The majority of passenger cars built in the States, and also some built here, have been equipped with ordinary O. H. steel roofs which are now causing a great deal of worry and expense due to corrosion, and copper bearing steel is now extensively specified with the expectation that the use of this material will solve this troublesome problem.

One large car-building concern in the States that not only builds cars for railroads but also owns and operates cars, recently constructed for test a number of cars using wood roof covered with canvas, and also a number of cars using galvanized iron for roofs, but as yet they are not in a position to judge as to the final roof to adopt. The wood and canvas roof as most extensively used in this country undoubtedly has a longer life.

Insulation

Steel in passenger cars demanded improved insulation, but it is evident from some designs that this important feature has been sadly neglected or misunderstood. Some attempts have been made to make up the deficiency in insulation by increasing the heating facilities, but these have proven costly. As the benefit of better insulation is understood, and is now considered absolutely necessary, great improvements have been made and cars built today are, as a rule, insulated with material having a thermal efficiency (based on table prepared by the National Bureau of Standards for Thermal Conductivities of Materials) that will not transmit more than 2.68 B.t.u. of heat per square foot of surface in 24 hours for each degree F. difference in temperature inside and outside wall of section, and 3.62 B.t.u. for floor.

The only data available covering requirements for insulation is the Mail Service Department specification for mail cars, which specifies that cars must be insulated with sufficient material of thermal efficiency that will not transmit more than 8 B.t.u. of heat for side walls, ends and roof, and not more than 7 B.t.u. of heat for floor per square foot of surface in 24 hours for each degree F. difference in temperature.

A coach or sleeping car requires more efficient insulation to overcome increased radiation and conduction, due to larger area of glass and increased leakage of air around the numerous window openings.

Wood and canvas roofs need no insulation except between steel carline and headlining, compared with a car having a steel roof which necessitates considerable insulation to protect the passenger from conduction of cold in winter and heat in summer.

Roof construction as used by some of the roads today gives a B.t.u. transmission of heat of 6.8 per square foot per 24 hours per degree F. difference in temperature and is composed as follows: Roof canvas, 13/16 in. roof board, air space, ¼ in. Salamander, headlining. This construction gives with only a small quantity of insulation better results than the requirement for mail cars and should be satisfactory, but it cannot be denied that improved insulation even for cars with wood roofs would make it possible to heat them with less steam.

Due to vertical members in framing, insulation cannot be applied in continuous lengths, but must be confined to a length suitable for individual spaces. It is, therefore, imperative, in order to prevent conduction, to use an insulating medium between all surfaces of steel in contact, and to isolate the outside steel plates from inside framing member so as to obtain an uncombined form of construction, otherwise in cold weather a frost line will appear on inside of car.

Freight Car Standards

In the earlier stages of steel car designs, the sizes of material were more or less based on the members used in wooden construction and, consequently, many of the early designs of freight cars proved defective, but served to develop a better knowledge of the relative value of steel and wood in car construction, and the use of the elastic limit rather than the ultimate strength.

The car constructed with wood underframing and wood draft timbers attached with bolts to the center sills, and with spring draft gear of light capacity, formed a very resilient structure, but when steel was introduced into car construction, while it developed a more rigid design, it has resulted in local damage to some of the members of the car, and in damage to the lading. The center sills, together with the draft gear, have become a live issue, the center sills to form a sustaining beam of sufficient strength not only to carry the load but also to form a column to take care of direct and indirect stresses, caused by buffing, the draft gear to form a shock absorber, protecting the car structure and the lading.

Spring draft gears in steel equipment having proven inadequate and costly and not of the capacities required are now being replaced by heavy-capacity, long-travel friction-gears so applied to cars that at no time will coupler horn come in contact with buffer casting, but instead transmit the buffing shock to center sills at rear draft lugs, which incidentally reduces the length of that portion of center sills which must absorb stresses due to buffing. With the spring-gear and

the final buffing shock taken by the buffer-block, the column is increased considerably and naturally makes a weaker structure.

Much has been written about the defects in early designs of steel freight cars through a lack of knowledge of the designer, but in spite of all the publicity, cars are built today which are little better than in the early days. I had occasion to analyze a recent design of car which showed combined stresses as high as 35,700 lb. per square inch in center sills. Some of these cars, no doubt, due to high stresses and rough handling in the classification yards, have landed on the repair track with failed center sills, together with many thousands of the older cars.

In 1907 an important change was introduced in box car construction when the steel-underframe, steel-superstructure box car made its appearance. This has become almost the universal car and today remains, except for minor refinements, much the same as the original design. As the steel-underframe took the place of the wood-underframe box car, so also now the steel-frame box cars are rapidly replacing the steel-underframe wood-superstructure, due to the impossibility of keeping the wood superstructure in repair on a rigid steel underframe. The posts and braces work loose, the frame and roof shift in either direction in heavy shunting, under which condition it is impossible to keep sheathing, lining and roof on the car for any length of time.

Hand brakes have been improved to meet A.R.A. requirements, and to obtain more efficient brakes, some cars have been equipped with gear brakes, and large numbers are being equipped with lever brakes, which have resulted in a great improvement over the old and inefficient hand brake wheel now in general use.

Steel has not altogether replaced wood for furrings and interior finish in passenger cars. For freight cars large quantities of lumber are, and always will be, used.

When building cars of all wood little attention was given to the moisture content, which it is so important and necessary for good construction to consider. Good dry lumber, as proven by test, becomes approximately two and one-half times stronger than the wood as it comes from the tree.

The tendency today is to construct freight cars with steel framing and wood lining and flooring, not only box cars but also types of open cars. This construction is more economical and repairs can be effected without expensive shop equipment. It is my opinion that this construction will be used in the future as the all-steel car, due to corrosion, has a short life and is expensive to repair, unless the use of copper bearing steel, now extensively specified, will overcome this deterioration.

Lumber, when used in freight cars with steel framing, serves only to retain the lading or form supports, and as lumber is classified by grade, it would lead to advantage and economy if more consideration was given to this subject when preparing specifications; that is, use a good grade of lumber for flooring and lining for box cars, and a lower grade for roofing, particularly as cars today are mostly equipped with outside metal roofs. The same principle also applies to coal and refrigerator cars.

Regarding the proper moisture content, it is comparatively simple to dry all lumber in a reasonably short time with the modern dry kiln, except oak, which requires a long time to dry. It will take from four to ten months to dry oak framing of sizes specified for car equipment.

Trucks and Springs

Freight car trucks have received due consideration; wheels have been redesigned and increased in weight, rating of axle carrying capacity increased for some capacity cars, and arch-bar trucks, which have been used for so many years, are being replaced by those with cast-steel frames. Today in the States 90 per cent of all freight cars built are equipped with cast-steel truck side frames.

By the use of this class of truck many parts are eliminated, as will be noted from the following table:

Type of trucks	Capacity	No. of parts	Weight two trucks	Parts saved	Weight saved	Reduction in parts, per cent	Reduction in weight, per cent
Arch bar...	40-ton	268	14,400 lb.	...	.....	..	..
Cast steel...	40-ton	128	14,000 lb.	140	400 lb.	52	3
Arch bar....	50-ton	304	17,000 lb.	...	.....	..	..
Cast steel...	50-ton	144	16,123 lb.	160	877 lb.	53	5

This comparison shows a reduction in parts of over 50 per cent in favor of the cast-steel truck and a reduction in weight, which, although small, is sufficient to receive consideration. The elimination of so many parts also minimizes delays caused by failures of arch-bar trucks which depend on bolts for securing the parts. These bolts after a short time become loose and the truck and car land on the repair tracks instead of being in service and earning revenue.

Attention has also turned towards obtaining better brake rigging, and there is a tendency to equip freight car trucks with clasp brakes. Some heavy capacity cars have already been so equipped, and I venture to state that all trucks for cars of 50-ton capacity and over will eventually be specified to include clasp brakes.

Truck spring failures have become serious of late, due partly to the recent increase in loading and partly to the change in method of stenciling the capacity on axle carrying capacity and increased rating without alteration in classification of truck springs. Failures have become so alarming that the A.R.A. recommended in 1921 the use of alloy steel and a change in method of manufacture, which, if adopted, would make the springs much more expensive, and would not solve the problem. These failures can be reduced, and possibly eliminated altogether, if the present standard of springs was reclassified, using class "D" for 80,000 lb. capacity cars, and class "H" for 100,000 lb. and 120,000 lb. capacity cars, as this would reduce the working stress to about 50 per cent of the ultimate allowable stress.

Table Showing Existing Conditions

Class	For cap. cars A.R.A.	Cap. of spring at 80,000 lb. per sq. in. fiber stress	Total load on each nest	Total deflection of spring at 80,000 lb. fiber stress	Percentage of total deflection due to load and car body	Percentage of total allowable fiber stress	Fiber stress due to load and car body, lb. per sq. in.
A	60,000 lb.	40,412 lb.	23,125 lb.	1 7/16 in.	57	57	45,600
C	80,000 lb.	56,320 lb.	29,875 lb.	1 11/16 in.	53	53	42,500
D	100,000 lb.	63,148 lb.	38,475 lb.	1 11/16 in.	61	61	48,900
H	*	79,145 lb.	38,475 lb.	1 1/16 in.	49	49	39,200

*Shows conditions that would exist if A.R.A. class "H" spring was used for cars with 5½ in. by 10 in. axles.

Conditions under old loading rules for 50-ton capacity cars were as follows:

Average dead weight car body and truck	42,000 lb.
Deduct weight of two trucks	17,000 lb.
	25,000 lb.
Add for two truck bolsters	1,800 lb.
Dead weight on bolster springs	26,800 lb.
Load plus 10 per cent for overload	110,000 lb.
Total load on springs	136,800 lb.
Load on each nest of truck springs	34,200 lb.

Figures in the table showing existing conditions for the same capacity car give an increased load of 4,275 lb. on each nest or a total increased loading on the four nests of 17,100 lb. or 12.5 per cent. This increased load, while not large, must have some relation between past and present spring failures, as it is the general practice to design helical springs so that the static load will not exceed 50 per cent of the maximum load at 80,000 lb. per square inch.

Stresses dut to static loads only, however, while a factor in causing spring failures are not the most serious. Other forces which create additional stresses must be added to the static load to obtain final results.

As stated in the M.C.B. proceedings, volume 30, if the center of gravity of the car is 72 in. above the rail 40 per

cent of the static load acting horizontally will almost entirely relieve the weight on one rail—which also acts on the springs—and to this must be added 26 per cent of the static load for vertical oscillation to obtain the combined load on each spring.

For example, a 60-ton capacity box car, maximum axle load 169,000 lb., as shown on the diagram, produces a static load on each nest of springs of 38,495 lb.

The resultant of a horizontal force, 40 per cent of load, equals 21,997 lb. which must be added to the static load on one set of springs and deducted from the static load on the other set of springs. To these figures the load due to vertical

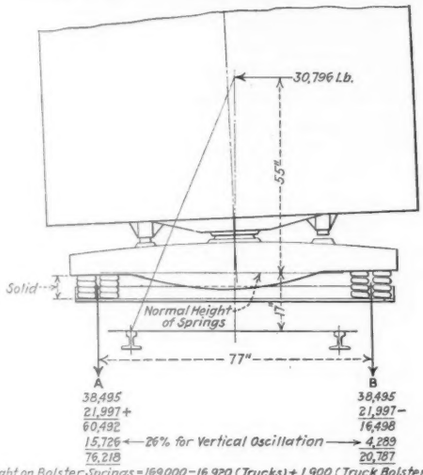


Diagram Showing Effect of Oscillation on Bolster Springs

oscillation must be added, which makes a total load of 76,218 lb. on one set of springs, and 20,787 lb. on the other side of the truck.

Under these conditions one set of springs are solid as the weight upon them exceeds the capacity of class "D" springs by 12,218 lb. and as the springs are subjected to these conditions time and again, but one result can be expected, which can be remedied only by introducing springs having greater capacity and more suitable for the conditions imposed.

Refrigerator Cars

Refrigerator cars transport the most valuable and expensive commodity handled by the railroads, and incidentally must carry cooling elements—ice—which is a dead loss in two ways, namely, the initial cost, and the weight carried without revenue. Although railroads have been faced with these losses for years, few attempts have been made to improve conditions until recently, no doubt for the reason that no data has been available to check losses of radiation and conduction, and select the proper insulating material and amount required.

It has been made possible, however, due to recent investigations, to calculate rather than conjecture what insulation and amount to use, and it is apparent that great improvement has been made in recent designs. Some cars lately built have been insulated with sufficient material of thermal efficiency to transmit no more than 2.6 B.t.u. of heat for wall, floor and roof sections per square foot of surface in 24 hours for each degree F. difference in temperature, but this is not sufficient, and greater improvement must be made in insulation of refrigerator cars. The extra cost of insulation would be insignificant compared with the saving, as I am sure that the present ice consumption can be reduced 50 per cent with better insulated cars.

In modern refrigerator cars the side insulation is required to run in one piece from door post to door post, and to be of sufficient width to run from side sill to side plate, which construction is ideal, but the old method of applying insulation in floor and roof is still maintained, namely, to apply insulation material between wood sills and carlines, which design invites poor construction on account of the numerous joints and furrings which may be fairly tight when new, but after a few months are bound to become loose and defeat the purpose intended.

I would therefore suggest that floor and roof insulation be applied in the same manner as used for sides, namely, in one piece covering the entire area, securely attached all around to eliminate all leakage possible. This will make the insulation more effective as well as reduce cost of application.

Most refrigerator cars today are constructed with steel underframe of a rigid design, with wood frame superstructure. Why not go further and apply steel framing for this class of equipment as well as for box cars? The steel superstructure will form a rigid support for sheathing, insulation and lining, and will hold them securely together and prevent radiation and conduction on account of the inadequate wood framing.

Painting

One of the most important, but from observation the most neglected requirement for preservation of equipment, is painting. It has been customary to paint the exposed surfaces only, and the unexposed surfaces, which are almost impossible to inspect for deterioration, left entirely unprotected, which practice has resulted in a premature failure and costly replacement.

The tendency now is to give the painting of cars the attention warranted, and equipment built of late has been painted with the utmost care. While the initial cost of good painting will amount to a few additional dollars per car, the cost is, after all, comparatively small when compared with the total cost of the car and is money well spent, as undoubtedly their life can be increased several years.

To obtain good results, however, it is necessary to clean by sand blast all steel parts before painting is attempted.

Replacement of Old Equipment

While this paper primarily was intended to deal with present tendencies in car construction, it may be interesting to refer to the program by the railways for replacing existing old wood cars. The replacement of passenger wood equipment with steel has been quite rapid in Canada, and the percentage of such replacement has exceeded that of the United States roads by a considerable margin.

From the report by the Interstate Commerce Commission for December, 1919, which is the only record available, the increase in steel passenger cars in the United States for three years has only been at the rate of about 3.2 per cent whereas in Canada during the same period the increase amounts to about 9 per cent of total cars owned and operated. However, out of about 7,040 passenger cars in Canada, only 17 per cent are yet of steel construction.

Similar conditions prevail regarding freight cars. The last report from the Interstate Commerce Commission shows a total of about 2,300,000 cars in the United States, of which 1,505,717 are all-steel or steel underframe construction, a total percentage of 65.5 per cent.

Canada's position in this regard is not so good, as out of 219,168 cars 47 per cent are all-steel or steel underframe construction. Fully 50 per cent of the wood construction cars have reached, and some exceeded, the normal expectancy of life, and should be replaced by modern equipment.

In the United States the annual retirement is about 72,000 cars or a percentage of .031 per cent of the total, and it may be assumed that the same percentage should prevail in Canada. At this rate Canadian roads should add about 7,000 cars per annum to maintain their present number of cars, which figure does not allow for any increase to take care of the normal growth of business.

Properties of Chilled-Iron Car Wheels

Investigation by University of Illinois of Stresses Due to Mounting, Static Load and Flange Pressure; Advantages from Increased Flange Thickness

AN investigation covering some of the properties of chilled-iron car wheels has been conducted at the University of Illinois, the work having been carried out under the direction of J. M. Snodgrass, professor of railway mechanical engineering, and F. H. Guldner, special investigator, and with the co-operation of the Association of Manufacturers of Chilled Car Wheels.

The results of that portion of the investigation dealing with the strains caused by forcing the wheel upon its axle and thereafter applying a static load were covered by Bulletin No. 129 of the Engineering Experimental Station.

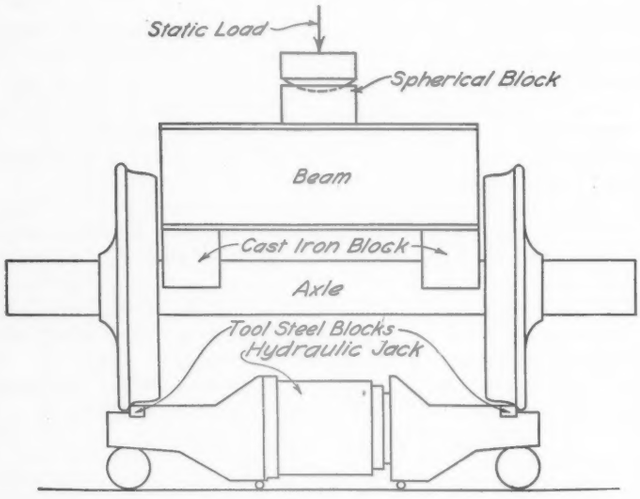


Fig. 1—Method of Applying Static Load and Flange Pressure

Abstracts from this bulletin were given in the *Railway Mechanical Engineer*, October, 1922. A continuation of the report is contained in a newly issued Bulletin No. 134 which deals with subsequent tests.

The first part of Bulletin No. 134 discusses the strains existing in a 33-in. 840-lb. wheel of the arch-plate type when subjected to the effect of mounting, static load and side thrust pressures, taken both individually and collectively. The remainder of the bulletin deals with a series of tests made to determine the ultimate strength of car wheel flanges, both new and worn.

Combined Effect of Mounting, Static Load and Flange Pressure

The equipment used to apply the loads for experimentally determining the combined effect of wheel fit, static load and flange pressure is shown in Fig. 1. It consisted of a 200-ton hydraulic jack supported on rolls which in turn were supported on the bed of a 600,000-lb. testing machine. Specially made castings fastened to each end of the jack had hardened tool steel blocks inserted near their ends, the upper sides of these blocks having contours similar to the head of a rail. A pair of wheels previously mounted on an axle rested on these steel blocks. By means of a block with a spherical seat, a beam, and two cast iron blocks resting on the axle, the static load was transmitted to the axle, thence through the wheels and on down to the bed of the testing machine. After a static load of the desired magnitude had been applied, a flange pressure of the desired amount was obtained by means of the hydraulic jack. The strains due to the various combinations of load were determined by means of a Berry strain-gage.

The strains were measured on a series of 2-in. gage lines, both radial and tangential, extending from the hub to near the rim on both inside and outside faces of the wheel tested. The static loads employed were 13,050 lb. and 25,450 lb. After the stresses due to these loads had been ascertained and while the static load of 25,450 lb. was still maintained, a side thrust or flange pressure of 8,000 lb. was added by means of the hydraulic jack. Additional readings were taken and the flange load then increased to 16,000 lb. and afterwards to 32,000 lb. The last condition, namely, 25,450 lb. static load and 32,000 lb. flange thrust, was considered to be representative of the normal maximum loading that might occur in service.

The compressive stresses found for the various load conditions were relatively unimportant. The maximum corresponding simple tensile stress—18,400 lb. per sq. in.—was due to mounting and was found at the gage-lines nearest the hub on the inner face. The application of static load and flange pressure did not materially affect this stress. Stresses of such magnitude occurring in the hub regions are generally less dangerous than stresses of lesser value at other positions in the wheel. This is due to the fact that the stress in the hub region is a steady one, that is, the material is not subjected to repeated stress. The combined effect of mounting and the application of a maximum static load and a flange pressure probably in excess of that encountered in normal wheel service was found to produce tension—with a few minor exceptions—in both radial and tangential directions on the outer face of the 840-lb. arch-plate wheel. On the inner face over the region investigated, this combination of loading was found to produce tension at the tangential and compression at the radial gage-lines. The tensile stresses on the outer face near the junction of the inner and outer plates resulting from the application of maximum static load and flange pressure are subject to repetition and at some points to complete reversal. The number of such reversals of stress that would occur in the normal life of a wheel, due to the occurrence of a sufficiently high flange pressure caused by traversing curves of small enough radius at high enough speed, is relatively small compared with the millions of reversals found necessary to cause failure under similar conditions in investigations of repeated stress. Hence, the question of severity of stress due to the combined effect of mounting, static load, and flange pressure may be considered from the static viewpoint alone. It does not appear that the stresses due to this combination of loading are severe in themselves, but if these stresses are increased by abuse of the wheel, through prolonged brake application, they might become large enough to cause incipient cracks leading to wheel failure.

Strength of Chilled-Iron Car Wheel Flanges

The apparatus used in making tests of the ultimate strength of the flanges consisted essentially of a steel beam built up of channels and plates as shown in Fig. 2. This beam was placed on the weighing table of a 600,000-lb. testing machine, and the wheel to be tested was supported thereon at opposite points on a diameter, at one side by a

piece of tool steel pressing against the flange, and at the other by a semi-circular piece of steel supporting the tread. The location of the point of application of the load on the flange could be varied by means of a block and wedge applied to the tread at a point diametrically opposite. This block and wedge further acted to take the horizontal pressure component due to the angularity of the flange at the point of load application. The load was applied to the wheel, through a block with a spherical seat. For this series of tests 33 wheels

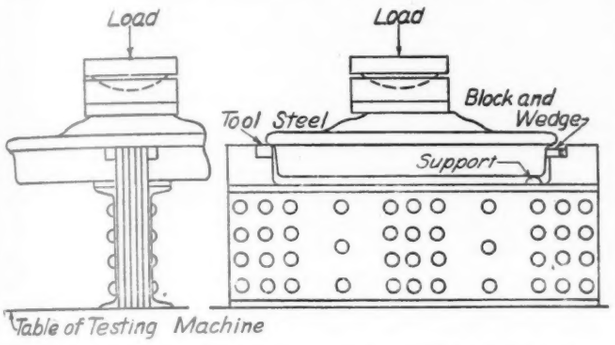


Fig. 2—Apparatus Used to Determine Strength of Flanges

were used and from three to six tests to fracture were made on each wheel.

The flanges were of various shapes and include specimens representative of both new and worn wheels. Among them were wheels with the standard contour recommended by the Master Car Builders' Association, and others with the reinforced flange suggested by the Association of Manufacturers of Chilled Car Wheels to replace the present M.C.B. standard flange. In addition, there were tests made on wheels with flanges ground to represent various stages of wear, and also on two wheels which were worn out in service.

In the case of a number of the wheels tested the flanges

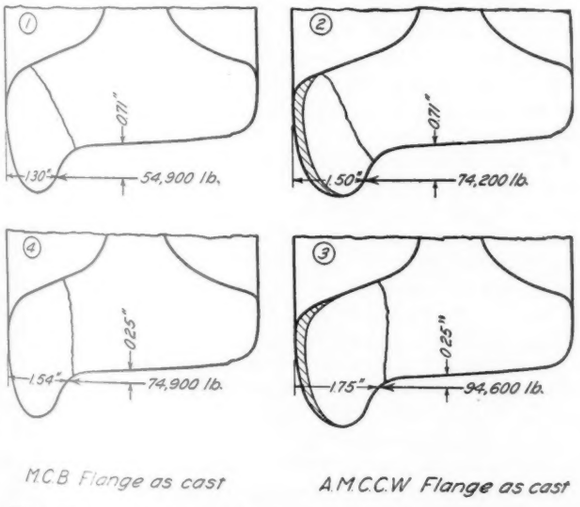


Fig. 3—Typical Results of Flange Tests on Special Wheel with Standard and Reinforced Flange

were ground to represent various stages of wear, so that the ultimate strengths determined in these cases furnish data as to the safety of wheels similarly worn in service. The location of the point at which the pressure was applied to the flange was also varied, and thus data were secured applicable to the case of wheels operating on improperly maintained track, on which the flanges may strike frogs, switches, etc. Irregularities occurred, however, in the results of these tests which preclude correct deductions concerning the effect of flange thickness. The irregularities in the results were caused by differences in the various wheels with respect to depth of chill, chemical composition, physical properties of the metal, etc.

In order to obtain information of value regarding the effect of additional metal in the flange region, an attempt was made to eliminate these differences by using wheels cast from special patterns, in which one-half of the circumference had the standard M.C.B. flange and the other half had additional metal on the inner face. Three types of wheels were thus cast and from these the effects in both new and worn wheels of, first, increasing the thickness of the flange, second, increasing the thickness of the tread, and, third, increasing the thickness of both flange and tread simultaneously, were determined. To make the comparisons still more direct the loads were in every case applied to the flanges of these specially prepared wheels on a radius midway between the points where two adjacent brackets entered the tread, thus eliminating as far as possible the complex effect of the support of the brackets. In addition, the flange pressures were in each case applied at identical distances below the tread,

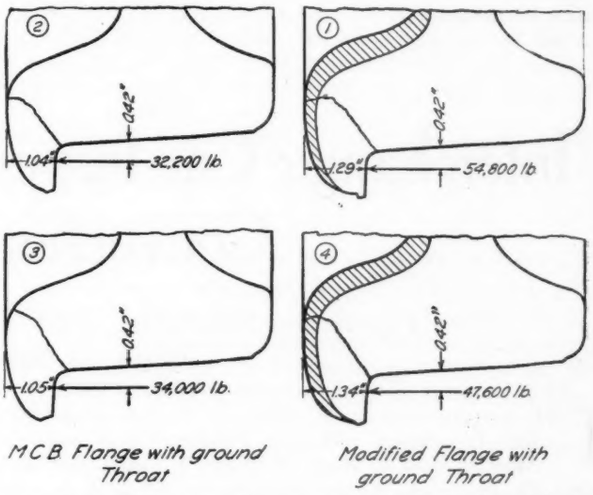


Fig. 4—Typical Test Results on Special Wheel with Standard Flange and with Reinforcement on Flange and Tread; Throat Ground to Represent Worn Flange

thereby removing the effect of difference in the moment of the load. Because of these precautions it is felt that the results obtained from these wheels cast from specially prepared patterns are truly representative.

Conclusion in Regard to Wheel Flanges

The conclusions to be drawn from the tests made to determine the ultimate strength of the wheel flange may, within the limits of these tests, be summarized as follows:

(1) When the flange pressure is applied to wheels with badly worn flanges on a radius midway between the points where two adjacent brackets enter the tread, the ultimate strength of the flange is an inverse function of the distance of the point of pressure application from the tread, that is, the greater the distance the smaller the ultimate strength.

(2) This inverse relation does not hold in the case of new or slightly worn flanges, neither does it hold in the case of either new or worn flanges if the point of pressure application is on the same radius as that on which a bracket enters the tread. In this case it was found in some of the tests that the bracket apparently strengthened the flange, while in others a weakening of the flange was observed, these conditions indicating a complex supporting effect due to the bracket.

(3) The addition of 3/16 in. of metal to the back of the present standard flange, as proposed by the Association of Manufacturers of Chilled Car Wheels, increases the ability of the flange to withstand side thrusts. This increased

strength was plainly shown in the tests of five specially prepared wheels, in which one-half of the circumference had the present standard M. C. B. flange and the other half the proposed additional flange thickness. These wheels showed an increased flange strength due to the additional metal of from 10 to 90 per cent in the case of badly worn flanges and from 26 to 49 per cent in the case of slightly worn or new flanges.

(4) In the case of the wheel having one-half of the circumference cast with the standard M. C. B. tread and the other half with the 3/16 in. of additional metal on the inner and under side of the tread, the results were negative, inasmuch as the half with the additional metal showed decreased ability to withstand side thrust. Although tests on one wheel cannot be taken as conclusive, if further tests confirm these results, the indication would be that it is possible to add metal in such a way that not only no increased flange strength results but a decreased flange strength may actually be caused. If this be taken as proved, then there probably exists a relation or ratio between flange and tread thickness which will result in a maximum flange strength for a particular thickness of either flange or tread. In that case if a wheel be cast with the ideal ratio of tread to flange thickness for, say, a given thickness of flange, the addition of metal to or the subtraction of metal from the tread will not only not increase the flange strength but may even decrease it.

(5) The simultaneous addition of 3/16 in. of metal to both flange and tread was not found to alter the ability of the flange to withstand side thrust. As the addition of 3/16 in. to the flange alone gave added strength, this result would tend to confirm the conclusion reached in (4). The simultaneous additions of 3/16 in. of metal to the flange and 3/8 in. to the tread was found to result in an appreciable increase in the ultimate strength of the flange. The weight of metal added was about 37 lbs. or 5.1 per cent of a 725-lb. wheel, whereas the increase in flange strength resulting therefrom ranged from 40 to 70 per cent. An important feature of this case is that the advantage of the additional metal apparently does not disappear as the wheel approaches the condemning limit on account of flange wear.

(6) The general conclusion to be drawn from the results of these tests is that the flange strength of the chilled iron wheel can be increased to keep pace with probable future service requirements by a proper placing of additional metal in the tread and flange.

Interchange Car Inspectors' and Car Foremen's Convention Proceedings

Papers on Scheduling Cars Through Repair Shops and on the Loading of Steel Products Discussed

THE program of the convention of the Chief Interchange Car Inspectors' and Car Foremen's Association of America held at Hotel Sherman, Chicago, November 9 and 10, 1922, was a long one. A discussion of the rules of interchange was given in the December issue of the *Railway Mechanical Engineer*. The January issue contained the papers and discussions on Tank Car Repairs, Carding and Handling Explosives and Apprenticeship System for the Car Department, while the February issue contained the papers on Successful Lubrication of Journal Boxes. The present issue contains additional interesting papers and an address by C. M. Dillon, representing the Association of Railway Executives.

Safe and Economical Loading of Steel Products

By W. R. Rogers
Chief Joint Inspector, Youngstown, Ohio

THE Loading Rules Committee has encouraged the manufacturers, railway clubs and individuals to offer suggestions for changes in the method of bracing and blocking the various ladings; and when we see the Committee's numerous revisions, from year to year, it appears that the field is broad for such activities. These revisions are made necessary on account of the ever changing conditions which require additions and modifications in the rules, and it is apparent that such suggestions should adhere to methods of securing loads in a practical, simple and, as far as possible, inexpensive manner.

The shippers fully appreciate that a dissatisfied customer often means loss of business, and that one sure way of losing the customer is to have his shipments delayed in transit or found at destination scattered over the car floor and in a damaged condition. It is, therefore, to the interest of the shipper to adhere to the rules, which provide substantial methods in bracing and securing the lading, and they are anxious and willing to co-operate with the carriers to that end.

The carriers' representatives with a full knowledge of the requirements of the rules, should visit the industries and explain to the shippers, in a business like manner, the various requirements of the rules, and assist the shipper in every possible manner. No opportunity, developing locally, should ever be lost to show the shipper, in the proper spirit, the results of improper loading. He will appreciate an opportunity to accompany you to inspect any such shipments received from his plant, that have given trouble on account of shifting, or for some other reason that was due to improper loading. There are many little courtesies that you can extend to the shippers in the way of suggestions as to how they can overcome some of the conditions developing in the loading of the various commodities which will be very beneficial to both the shippers and the carriers.

In territories where the industries are served by more than one railroad it has been found that if visits are made periodically, in company with representatives of the industry, much good will result in the way of adherence to the rules. We have safety first committees, loss and damage committees and fire prevention committees, each performing indispensable service. Why not industrial committees, representing the mechanical department, to cover such territories and perform a service to the common interest of the shippers and carriers?

The achievements of the Loading Rule Committees have not at all times been fully appreciated, and it is not the

intent or purpose of this paper to criticise the committee. In the opinion of the writer, however, the rules governing the loading of metal sheets and plates in box cars, the rules or absence of rules to cover the loading of long flexible concrete bars, and the rule covering super-imposed loads of plates on sides of gondola cars, are not impossible of improvement.

Loading Metal Sheets and Plates in Box Cars

I know of no other commodity loaded in box cars that is more destructive to the ends of the cars than sheets or plates, when not substantially secured to prevent shifting; and the cost to the railroads from this one source of damage to equipment, including the damage claims which are the result thereof, must amount to thousands of dollars annually. Under the rules in effect prior to January 1, 1922, there was no specified manner shown as to just how the bracing at the ends of piles towards the center of the car was to be secured, other than that it was to be well spiked to floor and car sides. In many cases the bracing was cut in the mill to the shippers' own standard lengths to save the cost of hand sawing, and quite frequently the bracing was nailed to the inside lining boards and possibly to but one post, with the result that such bracing was not sufficient to keep the lading from shifting.

Rule 265, as now written, and the figures as shown in Supplement No. 1 to the 1920 code, is far superior to any previous method of bracing and securing this commodity, but in making it so, the resultant increased cost has brought about some strong objections against adherence to the rule. Some shippers maintain that some of the sheets and plates are not so difficult to keep from shifting as others, and that the lengths of a large percentage of such shipments are such that they afford an opportunity to nail the bracing to a number of side posts and side braces, which the longer lengths do not. They contend that the rule should be modified to give them the benefit of any saving that the various conditions warrant. To meet this contention it is recommended that the rule be modified to the following extent:

For all sheets or plates, except oiled sheets, when piles do not exceed 36 in. in height, and for oiled sheets not exceeding 30 in. in height, where the length of sheets or plates will not permit securing of the longitudinal bracing, as shown in Fig. 90, to three posts or braces, the bracing must extend to the doorways and two additional pieces of 2-in. by 4-in, one piece at the top and one piece at the bottom, must extend across the doorways and be properly wedged against the bracing in the opposite end of the car. Where the longitudinal bracing can be secured to at least three posts or braces, the bracing need not extend to doorways and across doorways as now required.

For all sheets or plates in piles exceeding 36 in. in height, place in each of the above cases additional longitudinal bracing in the center between the top and bottom longitudinal bracing.

The piles, except oiled sheets, to be securely wedged apart by braces consisting of not less than two pieces of 2-in. by 4-in. uprights against each pile, these uprights to have 2-in. by 4-in. by 12-in. cleats nailed to them and the floor of the car, and to be securely wedged apart near the top by one 2-in. by 4-in. piece for piles not exceeding 18 in. in height and two pieces of 2-in. by 4-in., one near the bottom and one near the top, for loads exceeding 18 in. in height.

For oiled sheets, the piles should be wedged apart in the manner now prescribed in the rules, and as shown in Fig. 90, except that the bottom ends of the upright pieces should have 2-in. by 4-in. by 12-in. cleats nailed to them and to the floor of car, instead of cleats nailed to the floor on either side of the uprights as now required.

Forty-penny nails to be used in securing all end bracing to posts or braces, and not less than twenty-penny nails used to secure all other bracing.

Permit the use of 2-in. by 4-in. pieces, instead of the 2-in. by 8-in. against the car side at the ends of the piles. This one detail alone makes it necessary for the shipper to carry the 2-in. by 8-in. lumber in stock.

The advisability of the use of strips between the lading and sides of the car, when the sides will permit a uniform bearing surface, is also questioned. Cars are usually selected with reference to their fitness for this particular loading. The sides on such cars, as a general rule, will permit a uniform bearing surface, making the use of the strips unnecessary except as may be required to facilitate unloading, and it would appear that the bearing surface on the sides of the cars, when the lading is properly wedged against the sides, offers a much greater resistance to shifting of the lading than when the strips are used. It is the contention that their use be left optional with the shippers except when the sides are of uneven surface.

As an alternate method of loading flat galvanized or plain sheets not oiled, permit the loading of sheets 84 in. or longer in accordance with the present rule for bundle sheets, Fig. 92, provided that at least two 4-in. by 6-in. by 12-in. wedges are nailed to the car floor underneath each end of the pile, in order to secure the necessary concave on top of the pile.

The above modifications to the present rule would provide a means for some saving in the present cost of bracing such shipments, and would still be consistent with substantial bracing for this commodity.

Single Overhanging Loads of Concrete Bars

In loading single overhanging loads of long flexible concrete bars, it is the practice to follow the detailed instructions of the rules governing single over-hanging loads, using but one bearing timber on the floor of the carrying car, the other end of the material resting on the car floor. The overhang is taken care of by means of a sliding timber placed on the floor of the idler car between the body bolster and the end sill.

Rule 23, effective January 1, 1922 (see Supplement No. 1), now permits the loading of 58-ft. material on a 46-ft. car. This has greatly simplified the loading of concrete bars in lengths up to 58 ft., because heretofore it was necessary to load that length material as a twin load, requiring four sliding timbers in addition to the two bearing timbers.

From time to time the question has been raised as to the allowable weight permissible when such material is loaded as single overhanging loads, and we have been governed to a great extent by Rule 23, which shows the permissible weight for single overhanging loads, as shown in Fig. 52, 54 and 55. But there is some question as to whether a shipment of this long flexible material is not a somewhat different load than those shown in the above sketches and objections have been made because a greater weight than shown in that rule is not permitted.

The present rules permit the loading of a twin shipment of long flexible material to but one-half the capacity of the cars. But a great many shipments of this 60-ft. material have been loaded as single overhanging loads to the capacity of the carrying car, or 110,000 lb. on a 100,000-lb. capacity car, with a similar shipment loaded in reverse order, so that the one idler car takes care of the overhanging ends of both loads. When so loaded it required but three cars to carry 220,000 lb., whereas it would have required four cars and approximately 65 per cent additional labor and lumber to have loaded the shipments as twin loads.

If such materials as bridge girders loaded as single overhanging loads, as in Fig. 52, can be loaded on a 46-ft. car to a maximum weight of 85,000 lb. on a 100,000-lb. capacity car (see Rule 23), with no part of that weight carried

on the idler car, why would it not be feasible to increase that weight when the material is so flexible that the overhang rests on a sliding timber placed on the floor of the idler car, according to Rule 220? It is suggested that the rules show a drawing of a single overhanging load of flexible concrete bars with one bearing timber on the floor of the carrying car and a sliding timber on the floor of the idler car, and that they increase the allowable weight for such a shipment over that as shown in the table under Rule 23.

Twin Loads of Long Flexible Concrete Bars

A twin shipment of this material weighing 150,000 lb., in 60-ft. lengths, contains approximately 460 pieces of the 1¼-in. material and from 6,000 to 7,000 pieces of the ¼-in. and ⅜-in. material. The flexibility of the smaller size bars is such that four sliding timbers are required in addition to the bearing timbers, and it is simply a matter of building up the load and tying it together, so that the necessary clearance may be maintained between the floor and lading, at the same time providing for the proper functioning of the load on curves.

The bars are loaded in "lifts" weighing from three to four tons. The smaller size bars are usually tied in bundles, and some of the shippers, in order to facilitate removal of hooks and chains used in loading and unloading, place 4-in. by 4-in. timbers the full width of the load between the intermediate tiers. In the absence of rules to cover the loading of this particular material, the general rules covering twin shipments and the rules covering the loading of long flexible material are followed.

However, the flexibility of the smaller size bars is so great that there is some question as to whether or not the present rules covering the loading of long flexible material, such as plates, etc., should be adhered to in loading long concrete bars. The bars are corrugated or ribbed so that they will adhere to concrete construction and the ribs very often run at right angles to the bars. As the sliding timbers carry considerable weight, these ribs catch on the sliding irons, making it necessary that the sliding timbers, as well as the sliding irons, be very substantially secured to prevent their displacement. Some of the shippers of this material appreciate that condition and bolt the sliding irons and sliding timbers to the car floor, notwithstanding the fact that the rule covering the loading of twin shipments does not specify the manner in which the sliding timbers are to be secured.

We have experienced no trouble of any consequence with twin loads of this material when the bars were ⅞ in. or more in thickness, but the smaller size bars have given us considerable trouble. The rules covering the spacing of bearing timbers permit a variation from .6 to .8 of the total length of lading. By placing the bearing timbers .8 of the total length of lading, and thereby shortening up the length of the overhang, the use of sliding timbers to take care of the overhanging ends was eliminated on the less flexible or heavier bars. But this increases the swing of the load between the bearing timbers when moving over curves, and with the flexibility of the material the load did not at all times swing back in line with the track, making a dangerous condition. This is eliminated by shortening up the distance between the bearing timbers and spacing them .6 of total length of lading. This also relieves the sliding timbers between the bearing timbers of some of the weight that they would otherwise carry.

The drop end gondola cars of the fishbelly type of side and center sills are very desirable for such shipments, and fortunately they are the most available cars in the mill district. However, the thickness of the end gates on some of these cars is such that it is difficult to maintain the 4-in. clearance between the lading and the car floor, or rather between lading and dropped end gate. After using twelve 12-in. by 12-in. bearing timbers and 8-in. by 8-in. sliding timbers, it has been necessary in some cases to place three 6-in. blocks underneath the timbers in order to maintain that clearance, because of the deflection of the bars between the sliding timbers. A great many shipments of this material have been loaded with the sliding timbers placed between the car body bolster and the end sill, and when that practice is permitted it is not necessary, in many cases, to use any blocks under the timbers.

The present rules do not permit the placing of sliding timbers on twin shipments between the car body bolster and the end sill, but as there have been no apparent bad results when so placed, it would appear that this should be permitted. It is suggested that the rules show a drawing of a twin shipment of long flexible concrete bars, loaded on flat or drop end gondola cars, with the bearing timbers spaced preferably .6 of the total length of lading when the bars are ¾ in. in diameter or less, and not more than .7 of the total length of lading for bars of a greater diameter. Show the sliding timbers placed between the car body bolster and the end sill not more than 18 in. from the center line of the body bolster toward end sill on cars of all-steel or steel underframe construction, and require that they be secured to the car floor by ¾-in. bolts with a cleat underneath the floor, to prevent their displacement. Show sliding timbers to take care of the overhanging ends of the material when the flexibility of the overhang is such that their use is required, specifying that their thickness should not be greater than is required to keep the lading four inches clear of the floor, securing them in a substantial manner by the use of cleats on either side to prevent displacement. Show the use of 4-in. by 4-in. timbers the full width of the load between the intermediate tiers, their use to be optional with the shippers, but where used require that they be not placed within 24 in. of the vertical tie rods, in order to prevent the bending of the rods by the outer ends of the timbers when the lading shifts.

It is understood that the general rules covering twin shipments are to be followed with the above exceptions.

Special Plates on Top of the Sides of Gondola Cars

Rule 203 permits the loading of plates on top of the sides of gondola cars by two different methods, as shown in Figs. 45 and 45-A. If the method as outlined in Fig. 45 is followed and the plates are not all of the same uniform length, the shorter plates shift longitudinally against the end blocking, breaking and displacing it. If the method as outlined in Fig. 45-A is followed that condition is eliminated. It is suggested that the rule be so worded that the method as outlined in Fig. 45-A must be followed when the plates are not all of the same uniform length.

Discussion

C. M. Hitch (B. & O.): Those who have to do with the class of lading to which Mr. Rogers' paper refers will appreciate it sincerely. In some cases sheet steel is being loaded by the various shippers in a very careless manner. In order to improve these conditions and to obtain better results, we should have the mechanical representatives visit the loading points with our agents and traffic representatives, and encourage the shipper in loading such commodities in accordance with the rules. I heartily agree with Mr. Rogers.

Mr. Rogers: A copy of those proposed changes will be furnished to the Loading Rules Committee, and I also understand that the Loading Rules Committee is going into the question thoroughly, because of the fact that there has been so much agitation on account of the present rules requiring what appears to be excessive use of labor and material. There is no distinction between oil sheets or galvanized sheets or roof sheets. Almost anyone knows that it takes more bracing, better secured, to hold a ton of oil sheets than it does a ton of galvanized or corrugated roof sheets.

Mr. Hitch: We have a great many claims from shippers of sheet steel, and I do not believe that the loading rules that are in effect today go far enough to protect oil sheet steel.

T. J. O'Donnell (Buffalo, N. Y.): We receive, through our gateway, about 150 cars of steel almost every day, and with all the care they exercise in the Pittsburgh-Youngstown district, we have to cut in about one out of every ten. No matter how carefully you work out the loading rules on steel and its commodities, they will shift, more or less in ordinary handling.

Now, the Pittsburgh committee has done wonderful work in the last ten years. I think the chairman is Samuel Lynn, master car builder of the Pittsburgh & Lake Erie, and whenever you meet him he always makes it a point to ask if there is anything they can do to improve the loading of these commodities.

If they have cut down the necessity for the double load, they have certainly accomplished a great deal, because we are all looking for cars.

T. S. Cheadle (Richmond, Va.): You all realize that we have trouble with that class of material, and what a hard proposition it is to understand it, even with the valuable information contained in that paper. As a rule, the majority of us present do not deal directly with the shippers in loading these commodities. It is put up to the car inspector, who is on the job, and you can appreciate how hard it is for him to understand this rule. If anything can be done to get the shipper to co-operate with the railroad, it will mean a lot to the railroad and to the inspector, because most of the information that is gotten by the inspector is by observing the manner in which the other fellow does his work.

The information that we get at these conventions ordinarily does not get into the hands of the average inspector, and most of us do not have time to go out and give out the information we have. If anything can be done to get these things in such shape that they can be given out to the car inspector, who is going to handle a good deal of this work, we are going to effect a good deal of improvement.

T. J. O'Donnell (Buffalo, N. Y.): Our general chairman wanted me to bring to your attention a transcript of the minutes of one of our recent meetings, which deals with the attention that should be given to loading equipment.

[After the text of the Consolidated Classification rule requiring the shipper to furnish at his own expense the material required to properly secure the loading, and general rules 33 and 34 of the loading rules had been read, the chairman asked approval of the following letter from the Niagara Frontier Car Inspection Association addressed jointly to the secretaries of the Transportation, Mechanical and Freight Claims divisions of the American Railway Association. The text of the letter follows.—Editor.]

On behalf of the Niagara Frontier Car Inspection Association, we feel it our duty to call your attention to conditions existing at this frontier:

1. There is a very great hardship imposed upon the receiving line due to cars under load being received with old defects, when such defects are of a character which should have been noted and corrected, or the car not loaded, resulting frequently in transfer having to be made, causing not only heavy expense, but delay to equipment and to the freight.

2. Some railroads, if not all of them, apparently disregard American Railway Association Loading Rules and Rule 30 of Consolidated Classification No. 2, causing cars to be delayed for adjustment, because of no doorway protection being furnished at the loading point.

This is not only expensive, but delays the freight and equipment, where, if the rules were complied with, the doorway protection would have been furnished by the shippers and would have avoided the delay and expense, and also, in many cases, avoid damage to freight because of the protection securing the shipment in transit, preventing the freight from crowding the doors out and falling to the ground, becoming exposed to the elements and the possible chance, especially so on double track, of freight and swinging doors fouling trains on adjoining track, thereby endangering life and property.

It is, no doubt, true that for the first 100 miles, perhaps more, that the car travels, doorways are not in distress, but the lading is undergoing the process of creeping and sliding into the doorway, and shortly, due to service shocks or bumps in ordinary handling, the doorway is in distress and it is necessary to stop the car, placing it on shop track for adjustment. It is true that the Rules of Interchange provide for transfer and adjustment orders to be rendered against the delivering line, and this is a costly operation and could be avoided with proper inspection at the original point to see that cars are in fit condition to carry the load, and that proper doorway protection is applied.

We most respectfully request that your association at the coming convention, take under consideration the advisability of assessing the originating line for the cost of transfer and adjustments, where it is obvious that the defects causing the transfer were present at the time the car was loaded, and also that originating road failed to see that proper doorway protection was furnished at the time of loading.

Another matter that we should like to call attention to is the practice of permitting cars to be loaded in excess of the clearances published in the Railway Line Clearance Guide. To illustrate:

A railroad west of Chicago recently loaded a car of dump cars for a point on the New York, New Haven & Hartford. When delivered to connecting line at Buffalo it was found to be too high and wide, not only for the connection out of this frontier, but the final line as well, resulting in crane having to be used, also a second car to reduce the load, at an expense of about $58.

The responsibility, apparently, is with the originating line, who, we feel, should be penalized for non-observance of the published clearances.

We have been following these things closely for some time past, and from personal observation, know that a large sum of money could be saved yearly for the railroads of the country if a penalty were imposed upon the originating carrier for violation of rules governing the three matters referred to, i. e.:

1. Loading defective equipment.
2. Failure to furnish proper doorway protection.
3. Failure to see that cars are loaded so that dimensions do not exceed the published clearances of lines over which shipments are to move.

In the matter of defective condition of cars for loading, there may be a number of reasons, which are: Non-observance of the inspectors' markings; non-inspection of cars prior to loading, or the re-loading of a defective car after load has been discharged.

It may be that you now have all of these matters under consideration, but we desire to assure you we shall be glad to collect and tabulate the information for any period you may desire, up to a year, bearing upon the subjects mentioned, in this district.

All railroads, we believe, are carrying on strenuous freight claim prevention campaigns, and in this connection we do not know of anything that is more important than the different matters referred to, in accomplishing such reduction.

Let us speak frankly. There is no use evading the facts. These violations are going on right along and can and should be reduced to a minimum, which, if done, will not only save the large amount of money wasted—approximately $75,000 per year at this frontier—but will increase car mileage materially, as well as avoid delay and damage to freight, besides eliminating complaints from shippers.

In the case of doorway protection not being furnished, causing adjustment of several hundred cars per month, if it is not the intention of railroads to compel shippers to do this, as provided for, then the originating lines should do so at their own expense, and their failure to do so should compel them to pay the entire expense, including the per diem at the junction point where adjustment is made, same to apply on cars loaded too high or wide for clearances of roads over which routed, and also on cars transferred where known they were in defective condition when loaded, the expense to be billed direct against the road originating the load.

Yours respectfully (Signed) L. J. FERRITOR,
General Chairman.

Mr. Ferritor, our general chairman, is superintendent of the Wabash. He is very zealous in his effort to reduce these expenses, and he wanted this brought here for discussion.

Mr. Rogers: Let us go home and clean our own doorstep first—make our own agents use door protection where it is needed.

Mr. O'Donnell (Buffalo, N. Y.): We are doing that in our district. Our inspectors go in with the industrial managers and inspectors and see that they do it.

Mr. Rogers: I refer to our own freight agents, not our shippers.

Mr. O'Donnell: They heartily co-operate.

Mr. Cheadle: It seems to me that the only way these conditions can be overcome is by applying a penalty. I venture to say a good many of us did not know what our agents were doing until we began to get billed for that work. The car man has done all he could do.

Mr. O'Donnell: The commodities that give us trouble are first of all, baled hay; next barrel goods; next bags; then again, we have automobile parts, boxed up, that get into the doorway and become distressed. Any of those commodities should have three strips at the opening on each side. When you do not do that, you are going to damage your lading and sometimes cause loss of life on a double track line. The roads that take freight out of Buffalo are double track; the roads bringing it into Buffalo are single track.

We have a rate of $4 for adjustment of lading, $11 for

transfer. Take one thousand cars a month adjusted and you have $4,000 against the roads that bring it in. Most of it is on eastbound tonnage; the west bound takes care of itself.

Address By Charles M. Dillon*

Representing Association of Railway Executives

At no period in the history of this country has there been so much misrepresentation of railroads as in this last campaign, and it is leading people, particularly farmers, to believe that while they are undergoing great hardships, the railroads are profiting and piling up great earnings. The politicians in the West say to the farmers, "The railroads, in 1922, are going to have a net of $900,000,000." That is a tremendous sum of money to mention to anybody who is broke, with his notes due at the bank, and the prices of his crops declining. But these astute politicians do not tell the farmer that even if the railroads got the $900,000,000 net, they would be $186,750,000 short of making 5¾ per cent on the investment, which the Interstate Commerce Commission says it will recognize as a fair return.

One politician just elected to the Senate, in Nebraska, said in my hearing, "True, the guarantee to the railroads expires March 3, 1923, but after that date the Interstate Commerce Commission, under the Transportation Act, fixes the rate of guarantee and has fixed it at 5¾ per cent." That has a bad effect on the public and the farmers particularly, because they actually believe that the government guarantees a certain income to the railroads, and if the railroads do not earn it, the government pays it. The farmer has nothing guaranteed him and he does not like the idea.

These politicians in whom the farmer believes, are going to Washington now and it is going to affect every one of you and all your associates in the next three or four years. They are going there with a definite program with respect to railroads. One of the first items on that program are a number of amendments to the Transportation Act, and some of them are even going to try to repeal it.

In 1873 the railroads of this country had been overdeveloped. They had been developed so far ahead of industry that there was not enough traffic to provide a fair return on their investment. As a result many railroads went bankrupt and we had what is known as the railroad panic of 1873. Millions of dollars were lost to investors in that period, and that curse has been handed up from one generation to another until today, supplemented by labor disturbances and politicians, we have created a national state of mind which concerns itself mostly with cursing anything that runs on two rails.

Today business has so far outstripped the railroads that they cannot keep up with it, and we have the biggest car shortage that has ever been known.

How does this affect business? If these railroads are not to be permitted more freedom, if they are not to be assured a fair net return, which will attract investors, investors are not going to put their money in the railroads; and if they do not put their money in the railroads, we cannot extend them, we cannot buy new equipment and we cannot improve present facilities.

How can we help the situation? By doing everything we can to discourage further increases in the regulation of railroads, either by the states or by the federal government. You can have a very great influence, working among your friends and among the politicians, in discouraging any further regulation. There are 99 bodies regulating the railroads in this country. In Congress there is always somebody who has an idea about the railroads and you may be sure that in the state legislatures there are two or three or four or maybe two dozen who have some new ideas about controlling the railroads. It is now almost impossible to do anything without permission from somebody. The public is amply protected, and so are the employees, so that no harm could come to either, if we had a less restrictive form of regulation.

There has lately appeared to be among employees an increasingly friendly interest in the railroads, and some of them have been sending to our office for pamphlets. Now, we could not get away with falsehoods about the railroads if we tried to, because the facts are matters of public record, and we could immediately be called to account. So you may feel safe in sending for any information about the railroads you need.

*To the convention of the Chief Interchange Car Inspectors and Car Foremen, Chicago, November, 1922.

Scheduling Cars Through Repair Shops*

By E. H. Hall

Supt. Shops, Pere Marquette

SCHEDULING means two things to those who are responsible for shop operation. The first is output and the other is efficiency. These are attained by catching shop delays when they happen and not at the time you are expecting the car to leave the shop.

An important factor in scheduling equipment out of repair shops is first to establish a master schedule, and when a car arrives at the shop, to schedule or route that particular unit through the shop so that you know on the day it comes in what day it is going to leave there. The master schedule insures that you haven't all of your men on the one car at one time.

Having the master schedule, the first thing to be done is to make a thorough inspection of the car on the receiving track and determine what class of repairs it is to receive so that everybody in all the shops will know just when they are going to start on that car and when they are going to get off of it.

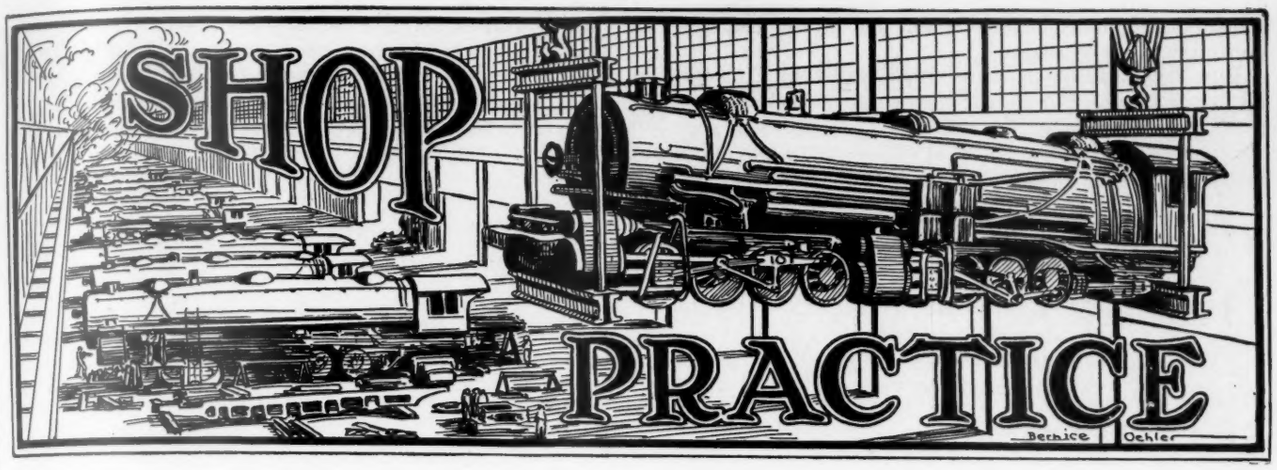
This tends to create rivalry between different departments. One department is often the cause of another department not being able to get its work out. Now, with a schedule, everybody in each department knows that he has to be off that car at a certain time because another gang from another department is due at that time. If the carpenter work and the finishing and trimming is not completed, the painters will be held up. The schedule uncovers the delay when it happens.

Each night you can go through the shop and make a summary of delays, and you can go out and investigate them right then. You can probably make up the time lost where one department blocks the other, and it is to each department foreman's interest to keep out of the way of the other fellow.

You cannot make the form of the schedule board uniform for all shops. Each shop should prepare it in accordance with their classification of repairs and with their master schedules.

If any of you have gone through the Angus shops of the Canadian Pacific at Montreal, Que., you would readily realize what the schedule means, because I believe that shop has accomplished more through scheduling equipment than any other shop in this country. In my opinion, shop scheduling is far superior plan to the piecework schedule, because you have each fellow timed in a way that is not a dollar and cents proposition to him. You are figuring on output and you can revise the master schedules and pinch the time in one department if you think they are being allowed too much time, and are crowding another department. The result is that you will increase your output and the work will be more uniform, because each department is trying to keep out of the way of the other fellow.

*Paper presented at the convention of the Chief Car Inspectors and Car Foremen, Chicago, November, 1922.



Motion Work Bushing Press

A QUICK-ACTING press for applying and removing motion work bushings is illustrated in Fig. 1, the general arrangement of the press, piping and driving pulley being shown in Fig. 2. This hydraulic press is driven by a

Fig. 1—Quick-Action 35-Ton Bushing Press in Operation

belt through tight and loose pulleys. It has the advantages of being compact and quick acting and gives pressures up to 35 tons. When located in the machine shop convenient to the motion work job, a large amount of time and effort, formerly spent trucking motion work to the driving box press, will be saved, besides relieving the congestion at the larger press.

Referring to Fig. 2, the construction of the motion work bushing press will be obvious. The operating cylinder is supported between two substantial plates, rigidly distanced by four 3-in. round bars and nuts. The ram is operated by hydraulic pressure from the double eccentric plunger pump, a pressure gage and safety valve being provided as shown. The line of hydraulic pressure is indicated in Fig. 2, together with the position of the operating valve, supply, overflow and discharge pipes. The ram is returned, or raised, after each stroke by means of pneumatic pressure in the small cylinder at the top. This cylinder is made of 4-in. extra heavy pipe bored to a smooth surface internally and fitted with an air-tight piston. A suitable three-way valve controls the supply of air through a ½-in. pipe to this cylinder.

After a motion work bushing has been pressed out or in, as the case may be, the belt is thrown to the loose pulley,

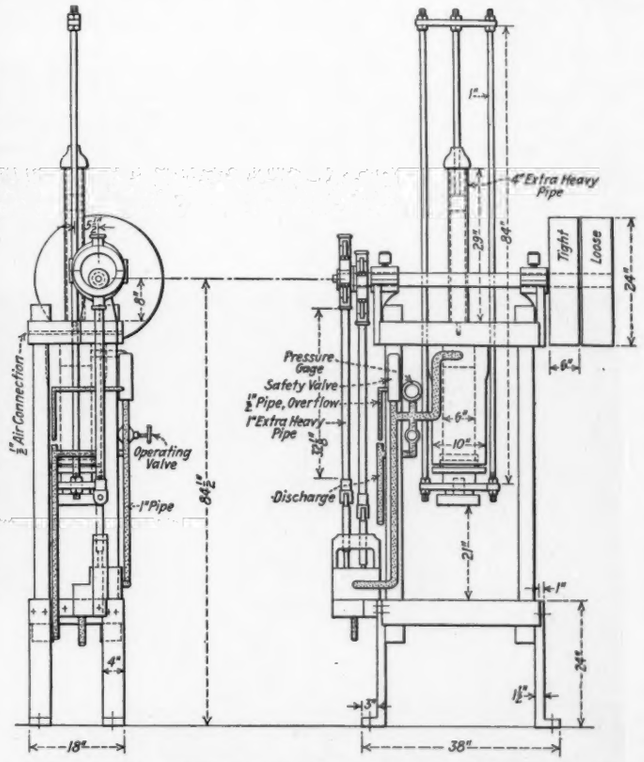


Fig. 2—General Arrangement and Dimensions of Hydraulic Bushing Press

stopping the pump. The main operating valve is opened wide, releasing pressure on the top of the ram and allowing free passage of the water to the discharge pipe, as pneumatic pressure in the small upper cylinder lifts the small piston, connecting rods and main ram. The upward movement of the ram is rapid but it can be stopped at any point in its

stroke, being immediately available for further use at whatever elevation it is stopped.

Fig. 1 shows this hydraulic press applying a bushing to the foot of a lap and lead lever used in a Walschaert valve gear. The location of the press close to the wall and the small amount of space taken is plainly shown in the illustration. Presses of this type are a material factor in speeding up the repair of locomotive motion work, besides leaving the heavier presses free for other work.

Hammers for Testing Stay Bolts

By C. W. Carter, Jr.
Olean, N. Y.

SEVERAL kinds of hammers are used for testing staybolts, but the hammers shown in the accompanying sketch have been adopted as standard by one of the largest railroads in the United States. There are two different hammers, the 1-lb. and the 1½-lb. The 1½-lb. hammer is used to detect broken or cracked flexible staybolts or bolts in the crown sheet. The 1-lb. hammer is used to detect cracked or broken bolts of the solid type located in the door and side sheets. The handle used in the hammer, as shown by the sketch, has a very thin cross section located about three inches from the head. These hammers give satisfactory results, but different methods should be used in order to detect the defective bolts in different types of boilers.

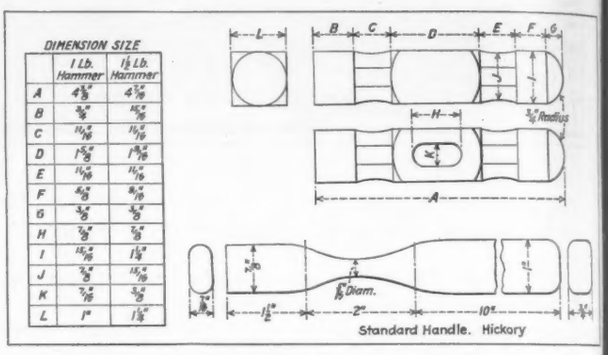
As a matter of fact, the hammer is not the only requirement in order to obtain good results, for a great deal depends upon the person doing the inspecting. If one is not adapted to the position of boiler inspector, it is useless for him to try to become an expert as such.

In my opinion, in going over a boiler on a staybolt test, the inspector cannot get all the broken and cracked bolts. I have witnessed inspectors undergoing examination who were classed as good, but the results they obtained varied, some locating only one defective bolt while others located as many as 12 or 14. Some bolts which they marked as broken or cracked were of the flexible type and were merely unseated.

In our larger type of boilers, we apply a 100-lb. cold water test as soon as it enters the shop for repairs. In this manner we are able to get very good results in locating defective bolts, especially in the crown sheet.

Testing Flexible Bolts

To test flexible bolts, we remove all caps and strike the head of the bolt two or three good smart blows so as to finish the break if possible; then we take a round nose tool and strike the head first on one side then on the other, twisting it so that in case it is fractured it will break loose. I have seen several tell-tale holes leaking on hydrostatic tests, but have very seldom seen an inspector locate them while testing the bolts from the firebox side of the boiler.



Details of Staybolt Testing Hammers

In striking a staybolt, if the hammer gives a quick rebound, the bolt is all right, but if it does not rebound and apparently sticks to the bolt it is cracked or broken. One must not depend altogether on the rebound, but upon the sense of hearing as well; a fractured bolt gives off a dead sound and is very often easily detected by one standing close to the inspector at the time.

The federal government requires that staybolts tested with water in the boiler must have at least 50 pounds pressure, otherwise the water must be drained and the test made, in which case the vibration of the sheet will indicate any unsoundness; the latter test is preferable.

Fig. 1—Every Job and Every Man on the Roster of the Morris and Essex Division of the D., L. & W. Is Shown on this Despatch Board

Locomotive 1134 Crossing the Turntable at Hoboken to take D. L. & W. Train No. 5 to Buffalo.

Despatch Board Gives Effective Control of Locomotives and Crews

SIMPLICITY and effective control of locomotives and crews are secured at the Hoboken enginehouse of the Delaware, Lackawanna & Western by means of the despatch board illustrated. This despatch board was designed by T. F. Barton, master mechanic, and put in operation about three years ago. When first installed, it was looked on with considerable skepticism and disfavor, but the fact that it is still in use after three years' trial proves its value for the purpose intended.

Fig. 2—Close-up of Corner of Despatch Board Showing Regular Passenger Runs and Extra Board

This board is of great assistance in handling the work of the despatcher's office at Hoboken for three reasons. It enables the despatcher to give information promptly and accurately; it gives him a check on his work; and it saves answering numberless questions which the crews can answer for themselves by simply looking at the board.

Every job and every man on the roster of the Morris & Essex division of the Lackawanna is shown on the board in Fig. 1 (see opposite page). These jobs are handled out of Hoboken terminal and 11 outside points where locomotives tie up and lay over. A log book is kept for a permanent record of messages received and moves made, but, by means of this despatch board, the despatcher has constantly in front of him the number of the locomotive to be used on each job, the time the job is called, the crew, and the present status of all crews, whether they are working, on the extra board, or laying off. The despatcher can therefore give any desired information promptly without the trouble and possibility of error involved in leafing through a voluminous log book.

The fact that all jobs and crews on the division are listed in a prominent place before the despatcher's eyes decreases the possibility of oversight in calling crews, or providing locomotives as needed. The location of the despatch board on the back wall of the despatcher's office where it can be readily seen through several windows from the engineman's room enables the crews also to examine the board and know who is assigned to each job. This saves the despatcher from answering many questions, and the men can exercise their seniority rights in the selection of desirable runs.

Description of Board

The despatch board is made of wood, about seven feet square, with headings painted at the top as indicated in Fig. 1. The names, train numbers, dates, etc., are printed on white cards which can be inserted and changed about in grooved card panels as desired. These card panels are removable, being held only by friction between the ends and the narrow vertical strips. Heading panels, such as "Harrison Drills," "Secaucus Tunnel Runs," etc., are twice as wide as card panels and are also removable for purposes of adjustment. If the number of Harrison switching jobs, for example, increases beyond the space allotted on the board, the heading "Harrison Drills" can be moved up one or more spaces, thus making room for additional cards. Compartments are pro-

vided at the bottom of the board containing extra cards, including those of enginemen and firemen who may have more than one run in 24 hours.

It will be noted that the despatch board is divided into six main vertical columns, the first two at the left being devoted to passenger runs, the third column to the "Extra Board" at the top and the "Laying Off Board" at the bottom, and the next three columns to extra freight, drill and roustabout jobs. Under the heading "Special Service," shown rather indistinctly at the bottom of the fifth column, are included the locomotives and crews assigned to extra jobs such as second sections, inspection trips, etc.

The two columns of regular passenger runs (shown in Fig. 2) indicate in each case the train number, time, locomotive number, enginemen and firemen, respectively. The "Extra Board" contains the name of each extra engineman and fireman together with the date and time of his last run. This affords a valuable check against calling him again inside of eight hours. The "Extra Board" also establishes the order in which men are to be called to substitute on regular jobs and thereby helps the despatcher. Another feature of importance is that a small red slip is inserted in front of the name of every man on the "Extra Board," and this slip is transferred with the name when the man is assigned to a job. In this way every extra man, whether on duty or not, can be instantly located on the board.

The "Laying Off Board" shows the name of each engineman and fireman who for any reason is off duty, and the date when leave of absence was granted. By showing the dates opposite each name, the despatcher is enabled to note and look up those who have been out unduly long without a satisfactory excuse.

Board Helps Locate "Missing Men"

As previously explained every man on the roster of the Morris & Essex division is shown on this despatch board. If he is not on the regular or "Laying Off Board" he must show on the "Extra Board." If not on the "Extra Board," the despatcher knows at a glance that he is missing and can endeavor to locate him. This is a very important feature, giving the despatcher a check on the men. Sometimes a job at one of the outlying points will be taken off the board and the despatcher not notified for 24 hours or possibly longer. If it were not for the board the crew might fail to report, laying off two or three extra days, possibly when most needed.

Holidays are usually busy times for the railroad and as is natural, many of the crews want permission to lay off. If they cannot get it, they use every possible subterfuge within their power. Sometimes they go on the "Laying Off Board" two or three days before a holiday in order to make sure that they get the day off. The despatcher has a check on this by means of the date, and then the fact that a man is known to be on the "Laying Off Board" has a tendency to prevent his staying off longer than necessary, especially if other men are trying to get permission to be off and cannot.

The operation of this despatch board may be made perhaps more clear by an illustration. If an engineman on a regular run is sick or has permission to be off duty, his card is simply taken from its regular place, leaving a vacancy, and put on the "Laying Off Board." The vacancy is a reminder to the despatcher that another engineer must be called two hours before the job starts to work. The despatcher then takes the card of the leading engineman from the "Extra Board" and puts it in the vacant place, calling the extra man two hours before the time the job is scheduled. The chances of oversight are thereby greatly reduced. When a regular man comes back he goes to work on his regular job and his card displaces that of the extra man who was taking his place. This extra man's card then goes back on the extra board with the date and time indicated, the man being available for call eight hours from that time. If an extra man lays off, when he returns to service his card is put on the "Extra Board" again.

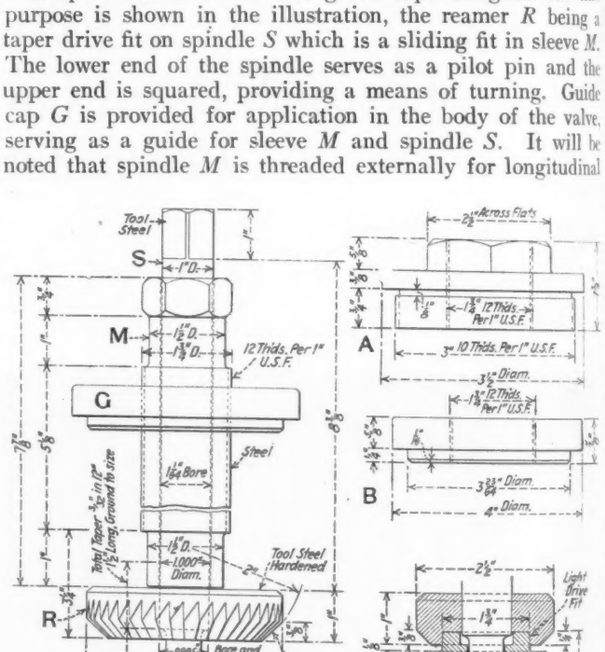
This despatch board is extremely flexible, comprehensive and readily understood. It is an invaluable aid to the Hoboken despatcher in controlling locomotives and crews on the Morris & Essex division of the Lackawanna.

Boiler Check Valve Seat Reamer

By E. A. Miller

OWING to excessive wear in service, boiler check valve seats frequently require a great deal of grinding. If the worn places on the valve seats are removed entirely by grinding with powdered emery or some other abrasive the operation takes a long time, and experience has shown that it is best to true up the seat with some form of reamer, the final grinding operation then being only a short one.

A special reamer with two guide caps designed for this purpose is shown in the illustration, the reamer *R* being a taper drive fit on spindle *S* which is a sliding fit in sleeve *M*. The lower end of the spindle serves as a pilot pin and the upper end is squared, providing a means of turning. Guide cap *G* is provided for application in the body of the valve, serving as a guide for sleeve *M* and spindle *S*. It will be noted that spindle *M* is threaded externally for longitudinal



Much Laborious Hand Grinding Is Saved by This Boiler Check Valve Seat Reamer

adjustment in guide cap *G*, being turned by means of the hexagon head at the top.

In operation, this device is inserted in the boiler check valve with the end of the spindle and the guide cap accurately positioning the reamer. Sleeve *M* is then turned down until the reamer bears with a slight pressure against the valve seat. Turning the spindle *S* with a wrench will then true the valve seat, sleeve *M* being tightened from time to time until all worn spots on the valve seat are removed.

Two kinds and several different sizes of guide caps are required, the cap illustrated at *A* being used for small check valves and threaded into the valve body. For larger valves the guide cap shown at *B* is used, having no thread and being kept in place in the valve by means of an outside plate.

For 3-in. valves and larger the type of reamer illustrated, giving a ball seat, is used. Smaller valves require an additional guide bushing as shown at *C* and have a 45-degree bevel. In certain cases the valve seat is flat.

Determination of Boiler Operating Factors

Part 1

Two-Part Article Showing Methods of Checking Boiler-Room Efficiency—Test Results Given

By D. C. Hess

Stoker Engineer, Westinghouse Electric & Manufacturing Co., Philadelphia, Pa.

RECENTLY there has been a radical change in the method of operating boiler plants equipped with underfeed stokers. There were times when it appeared to be common practice to drive all the boiler units in service at their maximum rating without regard for operating economy or maintenance costs. There are times in the average boiler plant when the sudden demand for steam

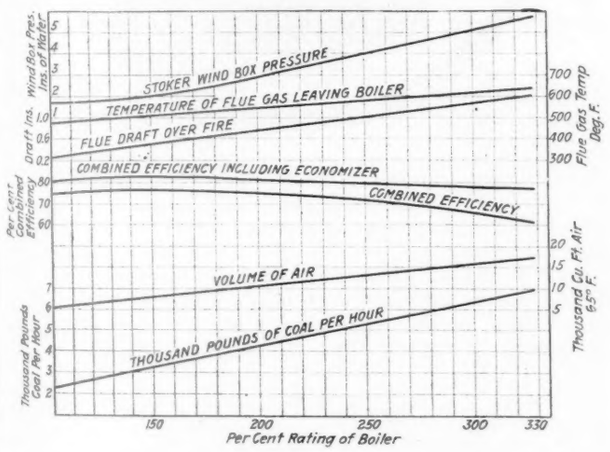


Fig. 1—Performance Curves of a Six-Retort Westinghouse Underfeed Stoker and 558 Hp. Boiler

requires that the boiler be operated at high ratings over the peak load periods. However, continued operation at high ratings for long periods has generally been recognized as not good engineering practice because of consequent low operating efficiency, lack of economy, and increased expense of maintenance.

Combustion Rates and Efficiencies

There is a certain combustion rate at which the stoker and boiler operate at their highest efficiency. This can be determined by running a series of short tests at varying rates of combustion, and, thereafter, an effort should be made to run as near this point as possible. However, usually this cannot be done because in case of a new plant the designing engineers have to consider various elements such as first cost, labor, etc. In the case of old installations, it will often be found that the load demand upon the station has outgrown the station, with resultant high overloads. In this discussion it should be considered that the plant will operate at the highest efficiency point, for if the plant operates at any other point, the same discussion holds good, but in a lesser degree.

Fig. 1 shows the result of a series of tests using Illinois coal in a six-retort Westinghouse underfeed stoker and a 558-hp. boiler. The grate area was 105.66 sq. ft. A rating of 328 per cent was obtained. The unit operated most efficiently at 160 per cent of normal boiler rating, when burning approximately 3,300 lb. of coal per hour, 550 lb. per retort, or 31.2 lb. per sq. ft. of grate surface.

Fig. 2 shows the results of a series of tests run with Pittsburgh district coal. Each 650-hp. boiler had a grate area of 123.27 sq. ft., which was supplied with fuel by a seven-retort Westinghouse underfeed stoker. The best efficiency was obtained at 185 per cent of normal boiler rating. It is also interesting to note the similarity between the combined efficiency and CO_2 curves of this test. There was a gradual rise in the flue gas temperature as the boiler rating was increased.

Operating Deductions

The results brought out by these tests show the essential conditions which are necessary to maintain the best operation of the stoker equipment. The point of highest combined efficiency for the first installation is 160 per cent of rating, while with the second equipment the best efficiency was obtained between 170 and 185 per cent of the rating.

The operating force in this plant has found that it can force this equipment to 328 per cent of rating if necessary. The condition of the furnace after a high rating test will

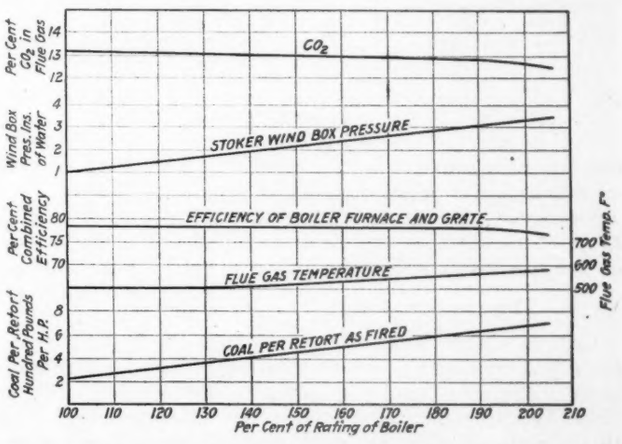


Fig. 2—Performance Curves of a Seven-Retort Underfeed Stoker Firing a 650 Hp. Boiler. Average B. t. u. of Coal As Fired=12,358

determine the effects of the high temperature on the furnace walls and stoker parts.

The type of stoker and fan driving equipment should be determined by the heat balance of the entire plant. If additional exhaust steam is required for feed water, engine- or turbine-drive will be preferable from an economy standpoint. On the other hand, if plenty of exhaust steam is available, it might be preferable to use motor drive.

Prevention of Clinker Formation

Clinker trouble is usually not so pronounced in most underfeed stoker installations until high ratings are reached, and high furnace temperatures are being maintained. If the coal being used contains a low fusing ash, it is evident

that clinker trouble will be encountered. Clinker in the fuel bed is hard to avoid, and in cases where they do not move to the rear with the movement of the fuel bed, a hook or slice bar has to be used. Recent changes in the design of boiler bridge walls tend to decrease furnace temperature and with it to some extent the formation of clinkers. This is accomplished by sloping the front surface of the bridge wall backward so that the rays of heat impinged upon it reflect directly into the boiler tubes and not back into the fuel bed. Also, the latest engineering practice is to expose all tube surface possible to the fire, thereby decreasing the furnace temperature.

In some plants side wall and bridge wall clinker troubles are avoided by the use of steam jets. On the other hand, many plants are using side wall tuyeres (Fig. 3) in connection with underfeed stokers. These side wall tuyeres are cast iron air boxes which extend above the side retorts and down along the side walls. They are rectangular in shape and fit closely together, but allow room for expansion and contraction. A large cored central space feeds air to the holes in the surface. The air issues at right angles to the wall or tuyere face. At plants where these side wall tuyeres are in use the side wall clinker trouble has been entirely eliminated, also the life of the boiler walls has been considerably increased. While the maintenance of the tuyeres is low, due to air cooling the metal, stokers equipped with these tuyeres burn high-ash western coals and low-ash

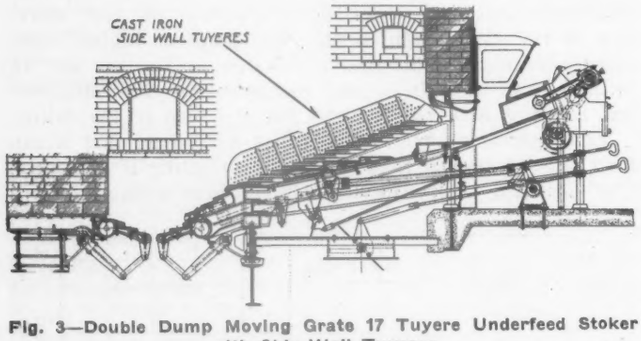


Fig. 3—Double Dump Moving Grate 17 Tuyere Underfeed Stoker with Side Wall Tuyeres

eastern coals equally well. Several furnaces have been in operation over three years with very satisfactory results. The air admitted through these side wall tuyeres has little or no effect on the CO_2 as the air is admitted below the surface of the fuel bed and serves as an aid to complete combustion.

Instruments Aid Efficient Operation

Central station engineers are fully aware of the necessity for supplementing an expensive boiler plant with a few reliable instruments that are absolutely necessary for efficient and successful stoker operation. This does not mean that an elaborate set of instruments is necessary, but every boiler plant unit should be equipped with draft gages for measuring the pressure of the air in the windbox, in the combustion chamber and in the last pass or in front of the stack damper. A recording or indicating CO_2 apparatus is also desirable for close combustion regulation.

Steam flow meters are extremely valuable boiler appliances. The use of such equipment gives a good check on the combined efficiency of the boiler and stoker.

The ability of the coal to ignite and burn readily in the grates is quickly determined by such actual operating tests. Moreover, such tests have repeatedly proved that very good results can be obtained from cheap coal. The proper ratio between the rate of coal feed and approximate air pressure for various grades of coal will be quite evident after a series of such tests, at different ratings.

Pyrometers are valuable for determining the flue gas temperature. A high stack temperature means that a relatively small amount of heat is being absorbed by the tubes. This is caused in most cases by defective baffling and dirty tube surfaces. Also a balanced draft in the combustion chamber decreases the infiltration of air through the setting, and thus

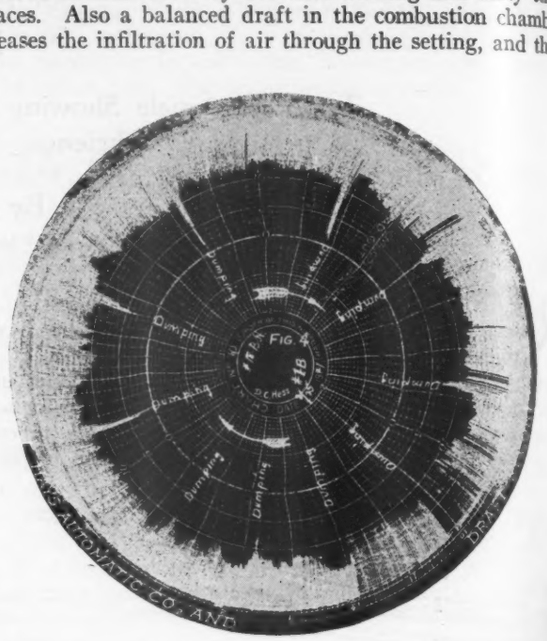


Fig. 4—A 24 Hr. CO_2 Chart Taken at a Western Pennsylvania Steel Plant. Average Value of CO_2, 12.5 Per Cent

is conducive to higher efficiency. Power plant engineers have taken time to study the theoretical side of combustion from its economy standpoint and have saved thousands of dollars each year in the fuel alone. They understand just what a two or three per cent increase in CO_2 means, also the greater evaporation per pound of coal by keeping the

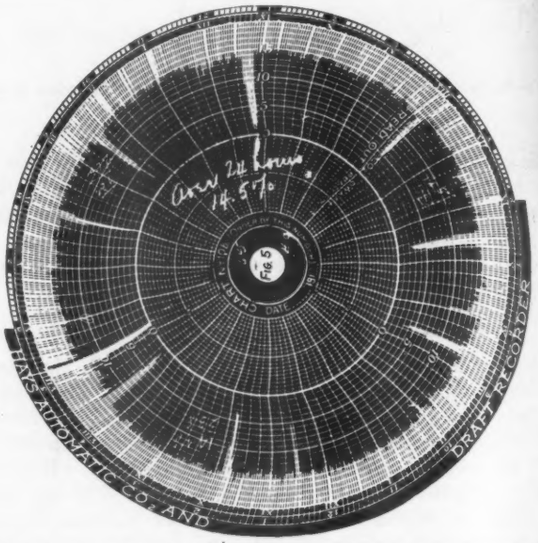


Fig. 5.—A 24 Hr. CO_2 Chart Taken at a Western Pennsylvania Steel Plant. Average Value of CO_2 on the Same Unit, 14.5 Per Cent

flue gas temperature at its lowest possible point. The result in dollars and cents has been most gratifying.

Fig. 4 shows a CO_2 record for 24 hours' operation, the average value being about 12.5 per cent. Fig. 5 shows a chart with an average CO_2 content of 14.5 per cent on the same unit. These CO_2 charts were made at a western Pennsylvania steel plant. They certainly tell the story to the management as to which is the best fireman and which unit is getting the best results. Note the CO_2 drop at each fuel

bed cleaning period, which is caused by excess air being admitted through the side doors and dump grate openings. This emphasizes the advantage of the mechanical steam dump which aids the operator in cleaning the fires quickly. Dampers are provided on the dump grates of the stokers under consideration, to prevent an excess of air from being admitted up through the dump grates at cleaning periods. These dampers are opened to burn excess fuel on the dump grates, thereby increasing the combustion rate and reducing the carbon content in the refuse. In comparing the two CO_2 charts it will be noted that there is a two per cent difference between the average of Figs. 4 and 5. This is approximately a two per cent fuel loss in the operation of the stoker from which Fig. 4 was taken. This fact emphasizes the importance of the boiler test for setting the operating pace.

(To be continued)

Shop Improvements Under Way at Richmond Hill

Important Improvements at Long Island Locomotive Shops Well Under Way—Some New Machines Already Working

PRACTICALLY all of the work involved in the repair and maintenance of Long Island locomotives is done at the general repair shops located at Richmond Hill, Long Island. These shops were operated for years with only minor improvements and in an endeavor to bring the shops

Fig. 1—Shaping a Reverse Lever Quadrant—New Steel Lockers in Background

up to date so that locomotive repairs can be carried on more effectively, the railroad has instituted an extensive improvement program under the direction of G. C. Bishop, superintendent of motive power.

This improvement program involves among other things the provision of additional crane facilities, with a 150-ton crane for handling locomotives. Considerable new machinery has been purchased, including a special car wheel boring machine and a double-acting wheel press. This machinery and the entire wheel job will be taken out of the main shop and segregated in an adjoining building, thus relieving the congestion in the main shop to a considerable extent and greatly facilitating the trucking of material back and forth through the shop. Every effort will be made to provide good working conditions and a step in this direction has been taken by the installation of new steel lockers in which the men can hang their clothing and personal effects. These lockers are distributed at convenient points throughout the shop, a series of 12 lockers being shown in the background of Fig. 1. These steel lockers replace old wooden lockers and boxes and, in addition to being considered very desirable by the men, greatly reduce the fire hazard. A master key is provided for the foremen, who, thereby, have access to the lockers for purposes of inspection or in case keys become lost. The possession of the master keys avoids the necessity of breaking into the lockers and in addition facilitates the periodical inspection of all lockers. Experience has shown that such inspections are necessary since the shopmen will otherwise succumb to their well-known weakness of accumulating large numbers of tools (many of which they can never use) in their private boxes or lockers.

New Machines Already Installed

Some of the new machines recently purchased have already been set up in the machine shop and are producing good

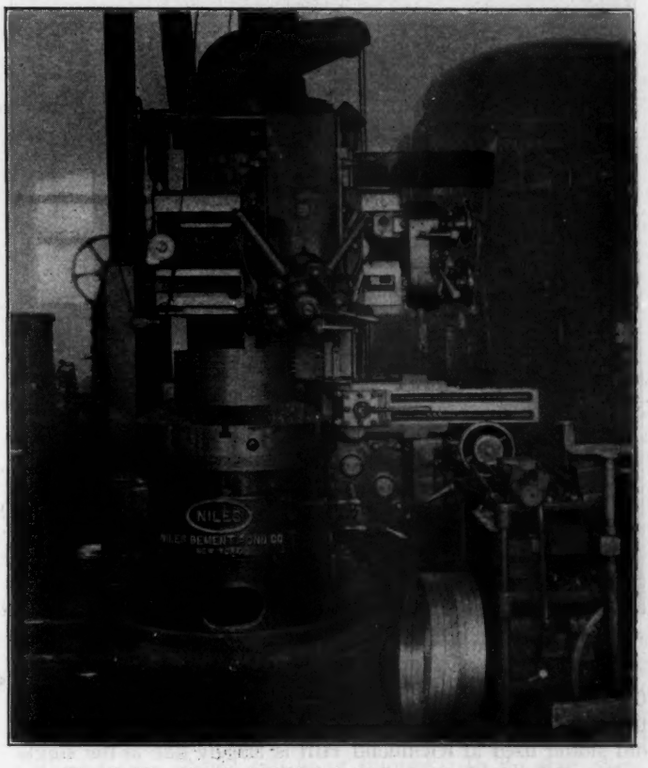


Fig. 2—The Vertical Turret Lathe—A Production Tool

work. One of the most productive of these machines is the vertical turret lathe illustrated in Fig. 2. This type of machine is of great value in railroad shops owing to the variety of locomotive parts which can be rapidly machined on it. The provision of the turret boring head in combination with the side head effects an important increase in the number

of operations which can be performed at one setting of the work. Speed and feed changes are quickly made and the convenient location of operating levers permits a big output to be secured from the machine.

The vertical turret lathe is used as in other shops for miscellaneous boring, turning and cutting-off operations on piston rings, piston heads, valve rings, valve chamber bushings, eccentric cams, eccentric strap liners, etc. The speeds and feeds used in making the piston rings illustrated in Fig. 2 may be of interest. These rings are 20½ in. in outside diameter, being 13/16 in. wide and ⅝ in. thick. There are 16 rings in a packing pot and it takes about 4½ hr. to set up the pot and machine the full set of rings. The inside and outside diameters are machined at the same time, using the boring and side heads with a feed of .037 in. per revolution. The speed of the packing pot is 13 r. p. m. The inside and outside diameters are then finished using the same feed but speeding up the packing pot to 18 r. p. m. The packing rings are cut off four at a time by means of the multiple cutter illustrated, using a feed of .004 in. per revolution and a speed of 9.3 r. p. m. Piston heads for the 20-in. cylinders are machined in about 1½ hr. Piston bull rings are bored, turned and faced in 3 hr. Piston spiders are bored and faced in 1½ hr.

One of the new machines which has proved adaptable to a wide variety of work is the 15-in. heavy duty slotter illustrated in Figs. 3 and 4. This machine is driven by a two-speed countershaft providing eight speeds from 8 to 48 strokes per minute. The available feed variation is from

Fig. 3—New Slotter Proves an Efficient and Versatile Machine

0 to ⅜ in. per stroke. After increased power and rigidity, the most important advantage of this new machine over the old slotter used at Richmond Hill is largely due to the single pulley drive with gear box enabling the speed changes to be made quickly. The clutch and brake are both on the same pulley at the rear of the machine, operation of the shifter in one direction applying the clutch and in the other direction the brake. By this arrangement the slotter can be stopped with the tool bar in any desired position. The gear-shifting mechanism is provided with an interlocking device which prevents any possibility of shifting the gears until the slotter is stopped. This makes the machine practically fool proof and prevents the possibility of stripping gears.

An important feature of this slotter is the arrangement of the tool bar with a home-made device for relieving pressure on the cutting tool on the return stroke. The cutting tool, best shown in Fig. 4, is held in a pivoted block arranged with a spring so that on the down stroke the block is held rigidly against the bar, but on the up stroke the block pivots, allowing the cutting tool to swing back and drag lightly on the work. In this way the cutting tool is relieved of heavy pressure on the return stroke, thereby greatly increasing the cutter life.

Slotting steel driving boxes for the crown brass and cellar

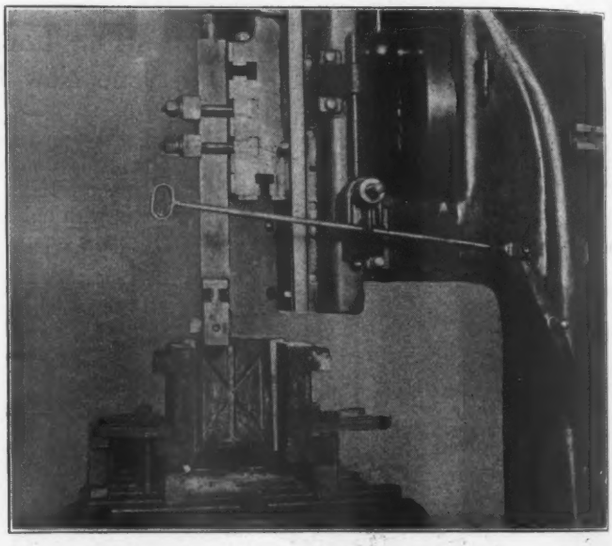


Fig. 4—Close-up of Slotter Ready to Machine Crown Brass

fits is one operation efficiently performed on this machine. The work is accurately and rapidly done and, on the 12-in. driving box shown in the illustration, takes approximately 2½ hr. A roughing and a finishing cut, using 3/32 in. feed in each case, are taken. For roughing, about 22 strokes per minute are made and for finishing, the slotter is speeded up to 28 strokes per minute. Keyways in driving wheels are slotted in 30 min. and in eccentric cams in about 20 min. respectively. The journal brass fits in cast-iron truck boxes are slotted in 1½ hr., including the time of set-up, using a feed of 3/32 in. and 37 strokes per minute. These truck boxes are used on the electrical equipment on the Long Island.

Another job which is peculiarly a slotter job is the machining of underhung steel spring stirrups. These stirrups are first planed on two sides but owing to their proportions, it would not be difficult to finish them on the planer. Each stirrup has to be machined where it fits up into the driving box and also where the spring has its bearing, as shown by the dotted lines in Fig. 5. As in all slotting jobs the time required will depend to a considerable extent on how much material must be removed. On the average, it takes two hours to rough and finish a spring stirrup using a 3/32-in. feed and 22 strokes per minute for the roughing cut. The same feed and 28 strokes per minute are used for the finishing cut. This machine is also used for general slotting operations as they come up in the shops.

Conveniently-Operated Hydraulic Press

The hydraulic press illustrated in Fig. 6 has been put in operation recently at Richmond Hill and may be accurately described as a labor-saving tool. It provides pressures up to 60 tons with a ram stroke of 30 in. for the

application of driving box crown brasses and rod bushings. When the press is not busy on this work, it is sometimes used for applying motion work bushings. The press applies crown brasses or rod bushings quickly by simply moving the lever shown in the operator's hand in Fig. 6. The gage above the operator's head registers the pressure, which must

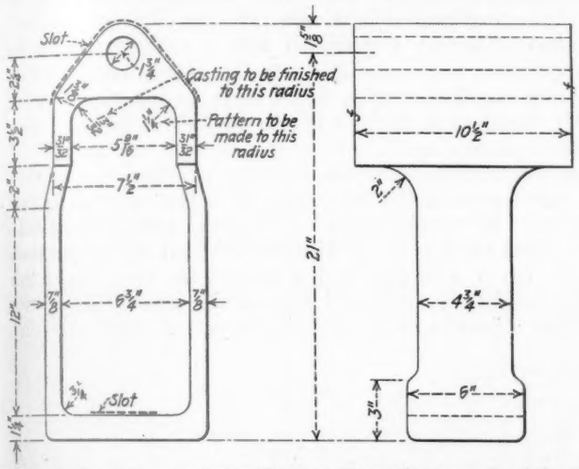


Fig. 5—Dotted Lines Indicate Slotting Operations on Steel Spring Stirrup

be held within certain definite limits. By means of a quick return stroke there is practically no lost time in getting ready for the application of the next driving box crown brass or rod bushing.

A convenient feature of this machine is the pneumatic auxiliary hoist shown at the left, arranged on a swinging arm along which it can move by means of the double roller car-

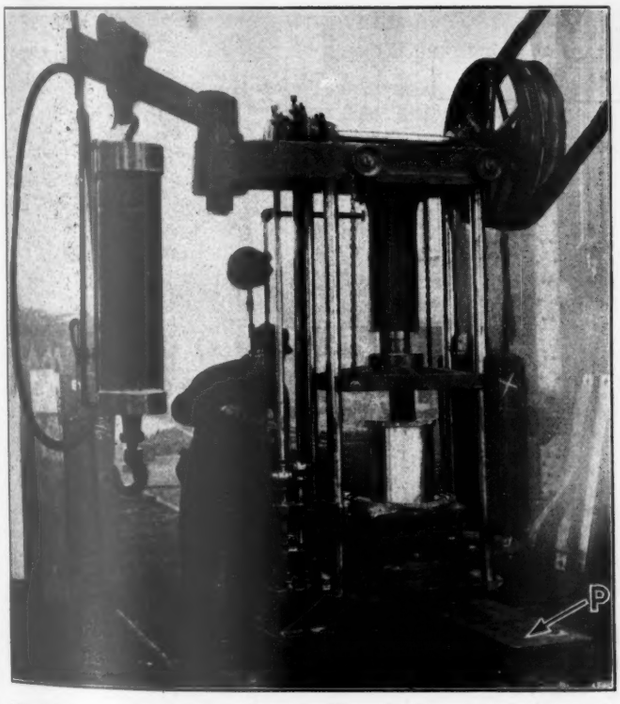


Fig. 6—A Reliable, Easily-Operated Press is Essential for Applying Crown Brasses

riage indicated. A rear view of the press is shown in order to make clear the arrangement of the cast-iron platform *P* arranged at the same height as the bed of the press. The driving box can be easily hoisted to this platform, slid along to the press and the brass applied by one man without the expenditure of a great amount of energy. Should a large number of driving boxes accumulate the provision of a helper to line up the boxes on the platform will materially speed up the operation.

The turret lathe illustrated in Fig. 7 is shown not because it is strictly speaking a new machine but because of the unusually large work being done on it. The cast-iron tank-well, shown in the illustration, is 14 in. in outside diameter and while primarily not a turret lathe job, this illustrates the capacity of the machine to handle large work in emergency.

Plain Milling Machine a Valuable Shop Tool

Another of the modern machines installed at Richmond Hill which is giving satisfactory performance is a large No. 5 plain knee-type milling machine. This machine is used with suitable milling cutters for machining motor car axle bearing brasses in gangs of three at a time, removing ¼ in. of metal with a table feed of 30 in. per min. and a spindle speed of 95 r. p. m. An unusual feature of this job was the discovery that cutters made of billet steel, case hardened, stood up better than high-speed steel cutters and showed a

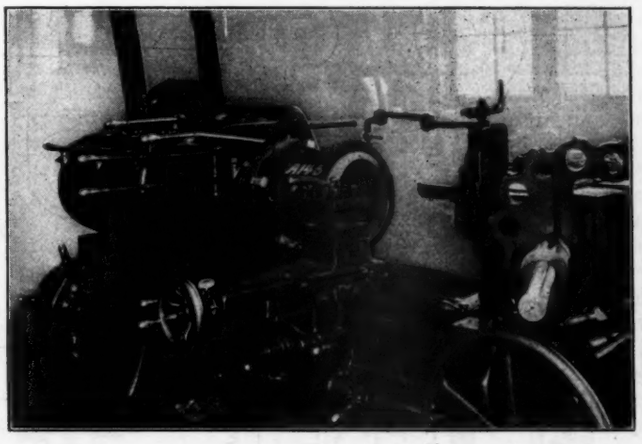


Fig. 7—Heavy Duty Turret Lathe with Chucking Equipment Machining Tankwell Casting

greater resistance to heating due to sand in the castings. It was not always possible to get good quality brass castings and after several experiments, case hardened cutters made of billet steel at the local shop were found to give the best service.

Both main and side rods are milled on this machine to advantage, the main rods being machined at the front end for the brass fit. It takes about 2½ hr., including the time of set-up, to mill the front end brass fit, the fit of the steel key block taking practically as much longer owing to the fact that an end mill must be used to machine for the shoulder. The fork ends of side rods are also machined on this miller in about ¾ hr. A spiral milling cutter supported at the outboard end is used, the cutter running at 24 r. p. m. and the feed being 5 in. per min. One roughing cut is taken through the center of the fork end leaving about 1/32 in. to be removed in the finish operation on either side.

Contrasting this operation with machining the side rod fork end on a slotter will be of interest. In the first place, several 2-in. holes, probably not less than four, would have to be drilled, taking in the neighborhood of three hours. Four hours would then be required to finish the fork end by slotting, the total time by this method being 7 hr., or a considerable increase over the time required to do the job on the milling machine. In addition to this work piston rod keyways, driving axle keyways, and many other small mill-

ing operations are performed to advantage on the plain knee-type miller.

Further details of the improvements at Richmond Hill will be described in the *Railway Mechanical Engineer* as soon as the work has been completed.

Control Valve and Distributing Valve Cylinder Grinder

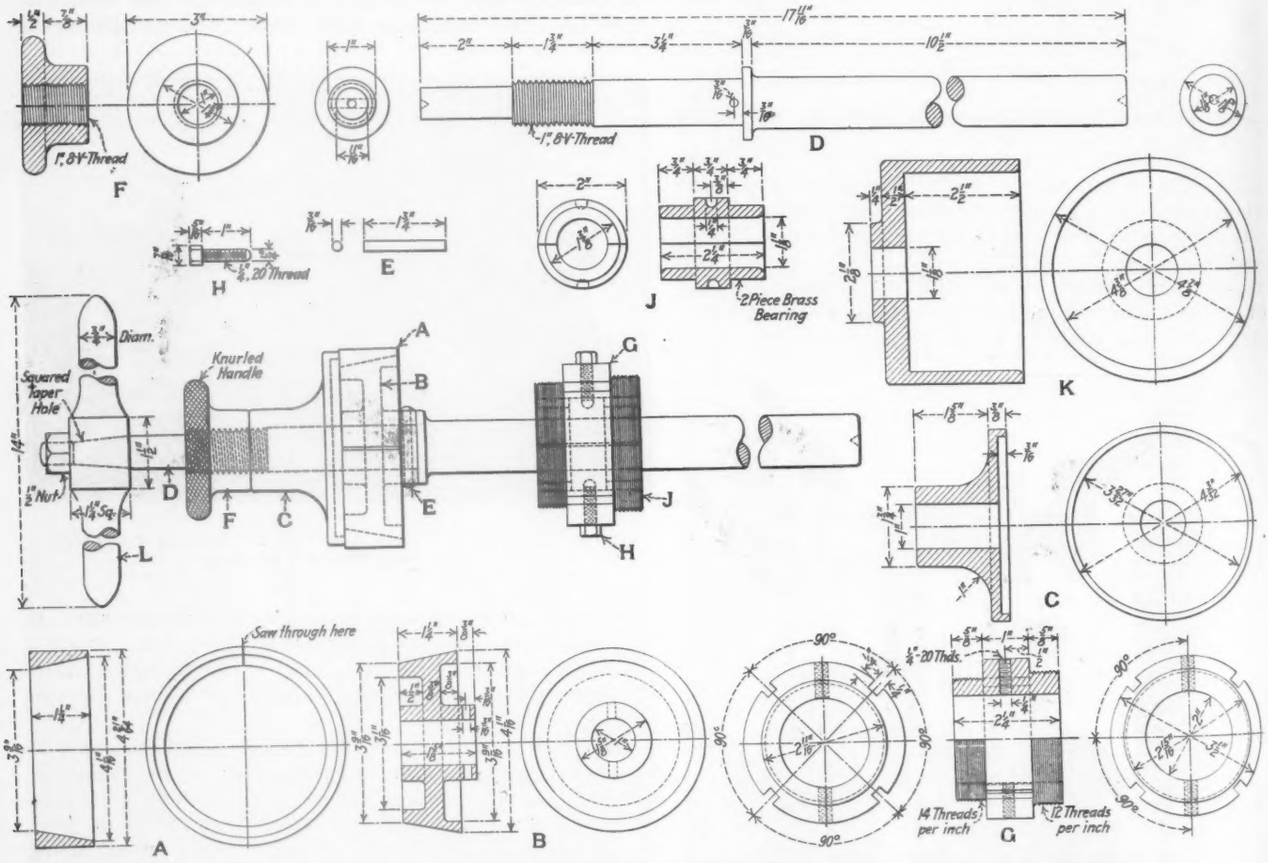
By J. D. Flinner

Supervsior of Air Brakes, Monongahela, Brownsville, Pa.

WHEN the cylinders of P. C. air brake control valves or E. T. distributing valves become worn and out of true, it is usually necessary to send them away to the factory for the application of new bushings, or the old cylinders must be trued on an internal grinding machine. This will enable new piston rings to be fitted accurately so that the valve will stand the test on a standard test rack. It costs money and takes time to ship valves away for the application of new bushings, and in many shops internal grinding machines are not available for truing the worn cylinders. Another way of overcoming the difficulty is by means of the tool, illustrated, which can be operated by hand and used to regrind and true worn control valve cylinders. (A similar tool could be readily devised for E. T. distributing valves or triple valves.) This tool is designed to true the cylinders of equalizing portions, one tool serving for both the equalizing and release cylinders, since they are both of the same diameter.

In general, the tool consists of an expanding ring *A*, on the outer surface of which is glued a piece of 00 Aloxite cloth which contains the abrasive and performs the grinding. Ring *A* is made to expand by longitudinal movement on taper part *B*, which revolves with arbor *D* through the action of pin *E*. Revolution of the knurled handle *F* to the right with the arbor *D* stationary, obviously expands ring *A*. The arbor is guided by part *G* provided with a suitable bushing and arranged with threads on either end, to suit the respective chucking threads of the valve. Revolution of arbor *D* and expanding ring *A* with the abrasive cloth are secured by means of handle *L* provided with a squared taper hole for application to the end of arbor *D*. A one-half inch nut holds this handle in place. Part *K* is a protection for the grinder when not in use and is also used when applying new Aloxite cloth to ring *A*.

The 00 Aloxite cloth, which forms the abrasive in this case, comes in rolls 1½ in. wide and 50 yd. long and is not expensive. It is easily applied, using any good glue as follows: First cut a piece of Aloxite cloth that will go around ring *A*, coat it with glue, put it around the ring, insert the grinder head in part *K* and expand the head. Allow the head and Aloxite cloth to remain in part *K* until the glue has become well set; then with a sharp knife trim off the edges extending over rings *A*, and the grinder is ready for use.



Assembled View and Details of a Simple, Effective Device for Truing Worn Control Valve Cylinders

In operation this grinder should not be inserted in the control valve cylinder until all oil or grease has been carefully removed. Then insert part *G* and apply the grinder in the cylinder with arbor *D* through the guide bushing. Holding handle *L* still, the knurled handle *F* is turned until ring *A* expands and fills the cylinder. Revolution of handle *L* will then perform the function of a grinding wheel and take a light cut from the cylinder.

Inasmuch as the outer surface of expanding ring *A* is an accurate cylinder, the tendency is to remove high spots in the control valve cylinder and true it. The ring *A* should not be expanded so that it turns with great difficulty. Better

results are obtained when the grinder turns easily, taking light cuts. The grinder should be pushed forward and back the full length of the cylinder while turning, thus giving a lapping effect which tends to keep the cylinder true as well as the grinder. A short time only is necessary to true cylinders with this device and as many as 40 have been ground with one piece of Aloxite cloth before renewal. It is highly essential that the cylinders be free from oil and grease.

Conveniently Located Lye Vat

IT is quite common to find railroad shop cleaning tanks or lye vats located in a small outbuilding at some distance from the main shop. In such a case the additional labor involved in trucking locomotive parts to and from the lye vat is considerable, to say nothing of the time lost in getting

Fig. 1—Locomotive Parts Are Quickly Cleaned in this Lye Vat Located in the Erecting Shop Next to the Stripping Pit

these parts to the departments where they are to be repaired. In addition, the building is frequently unheated, and the resulting formation of steam in cold weather not only delays the cleaning operations, but creates an undesirable hazard. To overcome these difficulties, a rectangular sheet iron lye vat has been placed next to the stripping pit in the transverse erecting shop of the Pittsburgh & Lake Erie at McKees Rocks, Pa. It was originally intended to place this lye vat in a vacant pit, but subsequently a special pit was dug between adjacent tracks and the lye vat inserted in one end as shown in Fig. 1. Construction details, given in the drawing (Fig. 2), are published by courtesy of Karl Berg, shop superintendent at McKees Rocks, who states that the lye vat has been a material help in speeding up cleaning operations.

This lye vat is large enough to take practically any locomotive part, with the exception of the driving wheels, and, being adjacent to the pit on which locomotives are stripped, brake rigging, spring rigging, binders, driving boxes, shoes and wedges, motion work, etc., can be quickly cleaned without undue trucking. Relatively small parts are placed in square baskets, one of which is shown in the lower right corner of Fig. 1. This basket is 3 ft. by 3 ft. by 4 ft. in size, being built of scrap boiler plates riveted to an angle iron frame work and having alternate square sections of the sides burned out as indicated, so that water can flow quickly in and out. This basket is arranged with a hinged bottom which may be tripped. Substantial ears on the sides enable it to be hoisted by a crane and suitable chains.

As the baskets are filled with locomotive parts needing cleaning, they are lowered in the lye vat and allowed to remain half an hour or whatever time may be necessary, depending on the amount of grease to be removed. At the end of that time the hinged safety covers on the lye vat are swung back and the baskets hoisted out, being moved one at a time to the other end of the pit where the parts are thoroughly rinsed off and cleaned with water from a hose. A close examination of Fig. 1 will show the guard rails which prevent any one from accidentally slipping and falling into the pit while performing this washing operation. The baskets are then hoisted out of the pit and the hinged bottoms tripped, allowing the parts to fall out on the floor where they are inspected, sorted and trucked to the proper shop departments.

Owing to the temperature of the parts, they dry quickly after being washed off and, as a result, clean, dry locomotive parts are sent to the various departments. This greatly increases the output and contentment of the men, as will be readily realized by anyone who has ever attempted to handle or repair locomotive parts only partially cleaned of dirt and grease.

Referring to Fig. 2, a plan and two elevations of the lye vat are shown, together with important details. The tank is practically 20 ft. long by 4 ft. wide by 5 ft. deep. It is built of ¼-in. boiler plate, angles, channels and Z-bars. It is supported on either side by plates under the pit rails and on the bottom by ten cross piers. The tank is grouted in place on these piers. A set of 1½-in. heater coils is provided in each side of the tank, being amply protected by

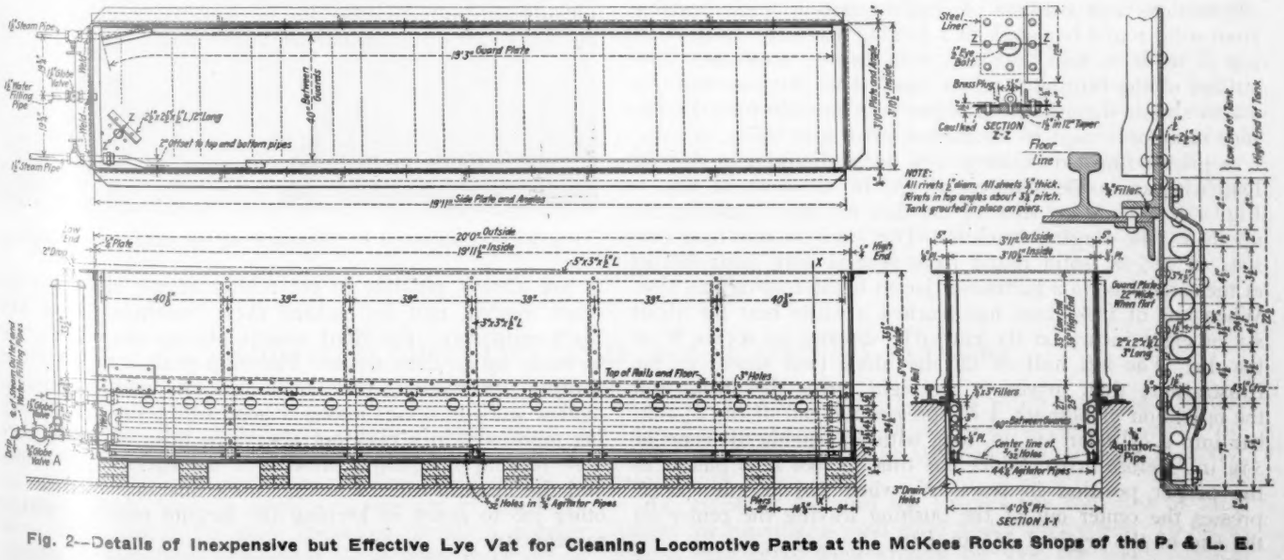


Fig. 2—Details of Inexpensive but Effective Lye Vat for Cleaning Locomotive Parts at the McKees Rocks Shops of the P. & L. E.

suitable guards. (It will be noted that the heater pipes are inclined so that no pocket is formed and the condensation drains out readily.) Globe valves control both the steam and the drip. A 1½-in. water-filling pipe is connected to the tank as indicated, also a brass plug in the bottom near the left end for cleaning purposes. From the detailed sketch it will be noted that the cleaning plug can be removed by means of an eye bolt, even though the tank be full of water.

A feature of this lye vat is the provision of an agitator pipe near the bottom of each side, drilled with 3/32-in. holes, so arranged that steam jets play on the bottom of the tank as shown in cross-section X-X (Fig. 2). This is an important feature, as it keeps the water in circulation, retards the formation of sludge on the bottom and hastens the cleaning of the parts. It will be noted that the steam inlet pipe to each agitator pipe is carried above the water level, this arrangement being necessary to prevent water from the tanks entering the 3/32-in. holes and backing up into the heater coil. Valve *A* controls the admission of steam to the agitator pipe.

Several interesting points developed when this lye vat was put in operation, one of them being that the parts to be cleaned must not be allowed to rest directly on the bottom. A false bottom was, therefore, constructed in four sections and made of channel irons placed crosswise, with longitudinal flattened boiler tubes riveted to them. By this arrangement the lye vat can be operated until the sludge in the bottom reaches the level of the boiler tubes. The tank is then emptied of water by means of the washout plug; the false bottom is lifted out, a section at a time; and the tank is cleaned in the ordinary manner by shoveling out the sludge. The false bottom is cleaned and reapplied, the tank then being filled with clean water and a new charge of alkali put in.

The temperature of the water in this lye vat can be readily maintained at the proper point by careful manipulation of the two inlet, two drip and two agitator pipe valves. With the drip valves closed, it is obvious that most of the steam admitted to the heating coils passes through to the agitator pipes, and this is usually sufficient to keep the water at the required temperature. Should it not be quite enough, the temperature can be raised by opening both steam inlet and drip valves a slightly greater amount. In general, it is desirable to keep the temperature of the water just below the boiling point so as not to waste steam, and yet get the maximum cleaning effect.

Forged Motion Work Bushings

ONE of the interesting jobs done in the Michigan Central blacksmith shop at Jackson, Mich., is shown in the illustrations and consists of making motion work bushings from solid round bar stock in a forging machine. Each bushing is made in one heat and with two or sometimes three strokes of the forging machine ram. The plungers and dies are of simple design and different sizes provide for all bushings commonly used in locomotive valve gear parts.

A pile of finished bushings 3⅝ in. in diameter by 4¼ in. long with an inside diameter of 2½ in. is shown in Fig. 1. Fig. 2 is a close-up view of the dies for these bushings set up in a 5-in. forging machine. The stock in this case consists of 2½-in. solid round bars, several bars being heated at the same time in a furnace adjacent to the forging machine. When one of these bars has reached a white heat for about six or eight inches on the end, it is inserted in recess *M* of the die. The left half of the die block (not shown in the illustration) then moves to the right, grips the stock, and the operation of plunger *A* compresses the end of the 2½-in. bar into a cylinder 4¼ in. long with an outside diameter of 3⅝ in. Before this cylinder has time to cool it is placed in the proper position in recess *N*, when 2½-in. plunger *B* presses the center out of the bushing leaving the center on the end of the original 2½-in. bar.

It will be noticed that this method is extremely economical, there being no waste of metal save for a few inches on the end of the 2½-in. bar. Bushings of the size shown can be made at the rate of about 25 an hour so that the labor cost is also small. Regarding the quality of the bushings, the result secured is entirely satisfactory. While it is probable

Fig. 1—Bushings Forged from 2½-In. Solid Round Bar Stock

that in tensile strength these bushings may not equal those machined from well-made tubing of good quality, it should be remembered that practically all of these bushings are pressed into various parts of the locomotive motion work or valve gear and are therefore subject to no bursting stress.

Another important advantage results from the fact that it

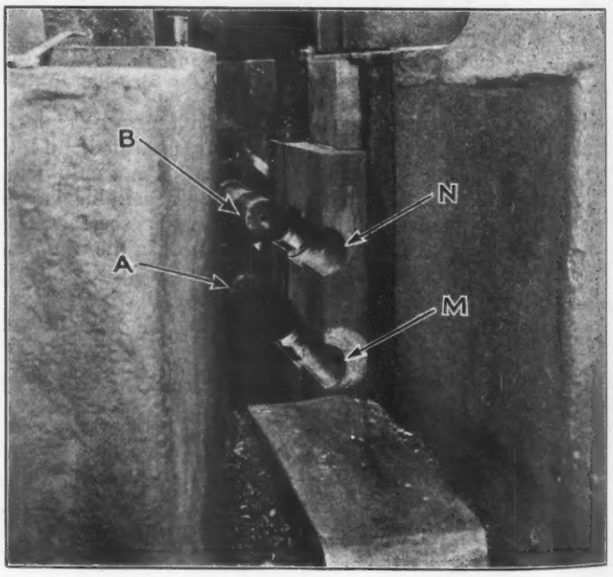
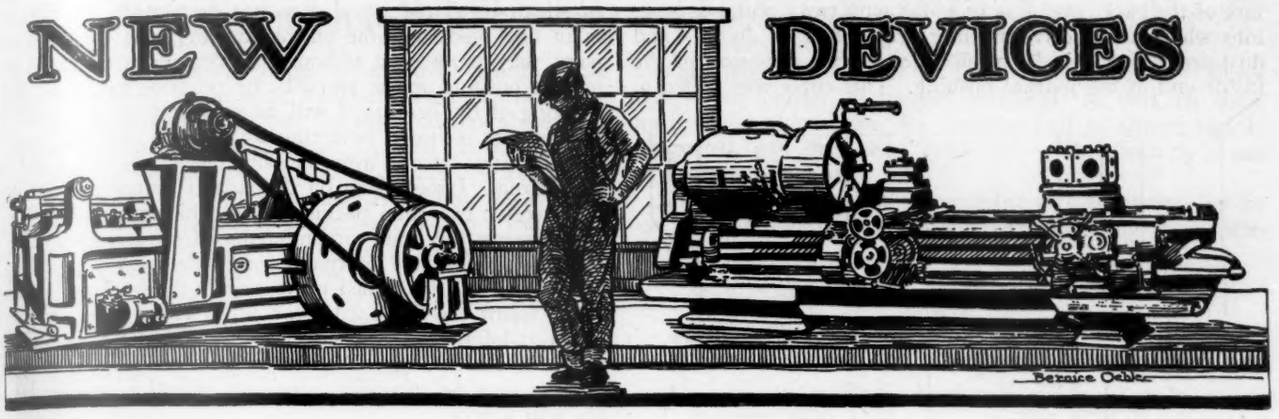


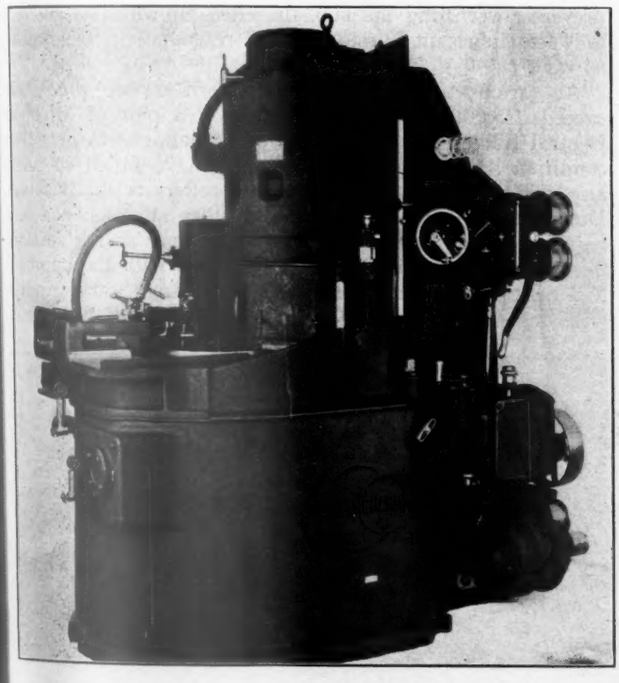
Fig. 2—Dies Adjusted in Forging Machine Ready for Operation

is not always possible to get tubing of the right size just when needed, and by making these bushings in the local blacksmith shop, the right size is always available or can be made up on short notice. The shop work is never held up waiting for motion work bushings. In addition, forging motion work bushings makes a good fill-in job for the forging machine which may not always be busy on heavy work. The forging machine represents a considerable investment and the manufacture of motion work bushings provides another job to assist in keeping the forging machine working to capacity.



Automatic Surface Grinding Machine

THE No. 16-A automatic surface grinder, recently brought out by the Blanchard Machine Co., Cambridge, Mass., bears the same relation to former types of surface grinders that the automatic screw machine bears to the engine lathe. The machine is not simply one with automatic features; it is entirely automatic in its operation. The machine automatically grinds work to size, measures the work, controls the adjustment of the wheelhead, unloads, and demagnetizes the work—all without the operator's attention. The operator's duty is simply to stand at the loading station and lay the work continuously on the revolving chuck.



Blanchard No. 16-A Automatic Surface Grinding Machine

It will help in understanding the operation of the machine to follow for one grinding operation the course of a piece through the machine. At the loading position, where the piece is first laid on the rotating magnetic chuck, there is no magnetism and the piece starts around with the chuck, held in place by its own weight. Just before the piece reaches the water-guards it is held magnetically and, passing through an opening in the guards, is carried under the wheel, which has been accurately adjusted to height by the preceding pieces.

In passing under the wheel the piece is ground to size and it then passes out through the water-guards and under the wheel control caliper which automatically sets the wheel head to compensate for any wheel-wear which has just occurred. After the piece has passed the caliper the chuck becomes non-magnetic and the piece leaves the chuck, passes through a demagnetizer and thence down a chute to the holding receptacles. After the piece is removed, the chuck surface is washed with water, and then cleaned, so that it reaches the loading position, clean and dry.

The rotating magnetic chuck is of one-piece steel construction and like other Blanchard magnetic chucks, is designed to be absolutely waterproof. As mentioned above, the chuck is only magnetic under the wheel and caliper; this is accomplished simply and without the use of sliding or moving contacts of any kind. The wheel control caliper is also of simple, sturdy construction so as not to get out of order or give trouble. The demagnetizer is connected to the motor circuit, starts and stops with the motors, and is of simple construction.

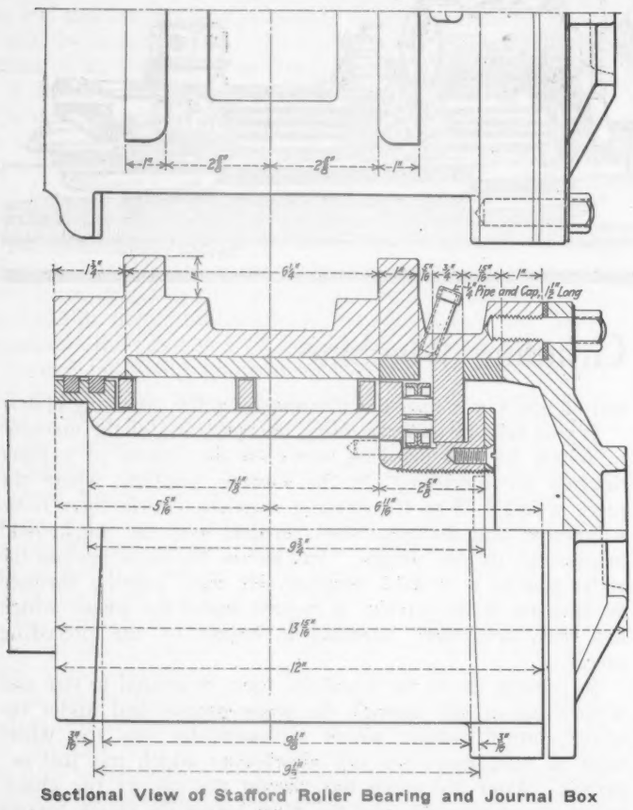
All controls are conveniently placed within easy reach of the operator. All important bearings and gears are lubricated by oil baths. Water-guards prevent splash and spray of coolant. The base forms a tank for 180 gallons of coolant and also acts as a settling pan from which the chips may be removed with the machine in operation. In the large railroad shops where many small parts requiring a ground finish can be made at one time this machine should prove a valuable time- and labor-saver.

Stafford Roller Bearings for Pedestal Trucks

EARLY in January, 1923, the trucks of Michigan Central baggage car No. 1142 were equipped with Stafford roller bearings to replace standard 5-in. by 9-in. M. C. B. axles. These bearings are similar in design to those which have been in service on one set of Michigan Central freight car trucks since December, 1920. A number of detailed improvements, however, have been incorporated in the recent design of the bearings which differ considerably from those incorporated in the original design briefly described in the Railway Age, daily edition, of June 16, 1922, page 1460.

As originally designed the journal box consisted of three parts: the housing, a front cover and a back cover. To maintain a dust proof joint around the axle the inside vertical

face of the back cover was provided with two circular grooves into which fitted corresponding projections on an oil- and dust-proof ring, which in effect formed an extension of the inside end of the journal bushing. This cover was bolted to



Sectional View of Stafford Roller Bearing and Journal Box

the housing and in order to remove the housing and bearing it was necessary to get at the nuts on the housing studs in the limited space between the back cover and the wheel. In order to remove the back cover and the dust-proof ring it was formerly necessary to remove the bushing from the journal.

In the new design, with the exception of the front cover, in which no important change has been made, the housing is in one piece and the entire housing, with all contained parts, may be removed without difficulty and without disturbing the bushing on the journal. By referring to the sectional drawing of the bearing it will be seen that the inner end of the housing is closed by a ring which slips over the journal bushing and extends over the shoulder at the inner end of the journal. Grooves cut on the outer circumference of this ring receive two snap packing rings which maintain a tight joint against the inner circumference of the housing.

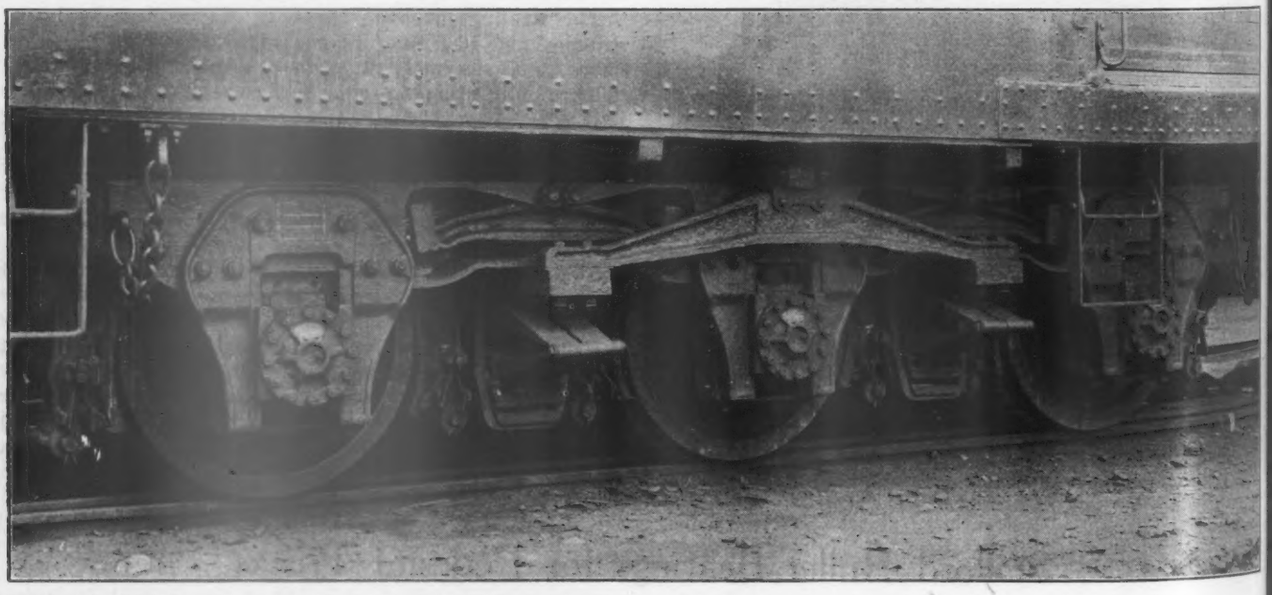
In applying these journals worn axles may be used. If the journal can be turned up to receive the bushing, without going below the standard wear limit, it may be continued in use indefinitely as the axle itself is subjected to no further wear. In the case of new axles the safe carrying capacity of the car may be increased, since no reduction in size takes place in service.

The main rollers and bushings and the thrust plates and rollers are of hardened chrome steel. The bushings are pressed into the cast steel housing with a pressure of 24,000 lb. and on the journal with a pressure of 8,000 lb.

Kind and Method of Lubrication

The approved lubricant for these bearings is a cylinder stock free from acids, alkalis and animal fats, semi-fluid in consistency. Instead of applying this through the opening shown in the drawing at the top of the box, a filling plug has been placed on the center line of the front cover. This prevents overfilling the box, the effect of which is not only to waste lubricant but to increase resistance in the bearing as well.

At various times during a period of service which now exceeds 25,000 miles, the bearings on a pair of Michigan Central freight car trucks have been examined to note their condition. Micrometer measurements have failed to reveal any evidence of wear, either on the rollers or the bushings. During this period, no repairs or other attention has been required by the bearings and the experience so far obtained indicates that one filling of the housings with the approved lubricant should run for two to three years. Starting resistance on straight, level track for a freight car of 122,600 lb. gross weight has been found to be four pounds per ton. For the baggage car, which has six-wheel trucks, the starting resistance, for the light weight of the car, is six pounds per ton.



Stafford Roller Bearings with Pedestal Type Boxes

Semi-Hot Bolt Header with Automatic Feed

A NEW and radical design of one-inch, semi-hot bolt and rivet heater with automatic feed has been developed by the engineers of the National Machinery Company, Tiffin, Ohio, and recently placed on the market. The bed frame in the new design, illustrated in Fig. 1, is only half as long as in previous models, and spring is practically eliminated, making it unnecessary to batter the heading tool against the gripping dies to properly fill out the head of the work. Some idea of the great strength and stiffness of the design is indicated by the fact that while the machine weighs 31,500 lb., it is only 51¾ in. from the center of the main shaft to the face plate, and the main shaft at the crank is 11½ in. in diameter.

The hard service and consequent wear on earlier automatic feed headers has been met by greatly increasing the size of all bearings and working surfaces, and adopting such features as the "suspended type" heading and gripping slides with bearings above the path of scale and water. All of the gripping toggles have been increased in size and are located horizontally to insure proper lubrication. The ultimate pressure that can be thrown upon the toggles and gripping mechanism is limited by a new type of automatic relief, making destructive pressures impossible. Last but not least, a fully automatic oiling system which oils every bearing of the machine automatically every ten minutes is provided, supplying a predetermined amount of oil for each bearing, proportionate to its service requirements. In a three-year test period, several machines of the new type have required no repairs or realinement, and working parts show practically no appreciable wear.

The previous trouble in die setting, resulting from the lack of a horizontal adjustment for the heading tool, has been overcome by mounting the heading tool in a bolster plate on the front of the heading slide, which, being screw-controlled in all directions, provides for quick and accurate adjustment of the heading tool with the gripping dies. This construction is outlined in Fig. 2. Where hours were previously required in alining the dies with the header, it is only a matter of minutes with this new construction. In fact, it is stated that users find it profitable to set up the machine for runs as low as 1,000 bolts or rivets. Three lengths of bolster plates are provided, so that on long, medium, or short work, the heading tool is always rigidly supported, and does not "overhang." This feature is one of great importance.

The lack of control of the gripping or holding time in the old machines has been corrected by providing an adjustment in the gripping toggles. Consequently, on work requiring minimum gather or hold, such as rivets, it is possible to reduce the holding time to the exact requirement. On work such as 1-in. U. S. square head bolts, or any work requiring a large amount of gather, the gather is obtainable by means of this adjustment. The practical result of limiting the contact with the heated stock is a reduction in heating effect on the dies, with a consequent lengthening of die life.

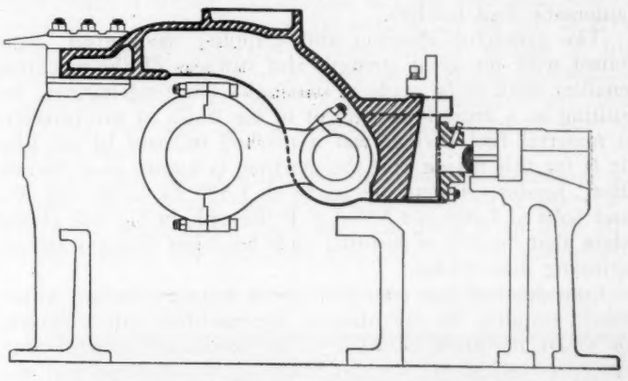


Fig. 2—Diagram Showing Heading Slide and Bolster Plate Construction

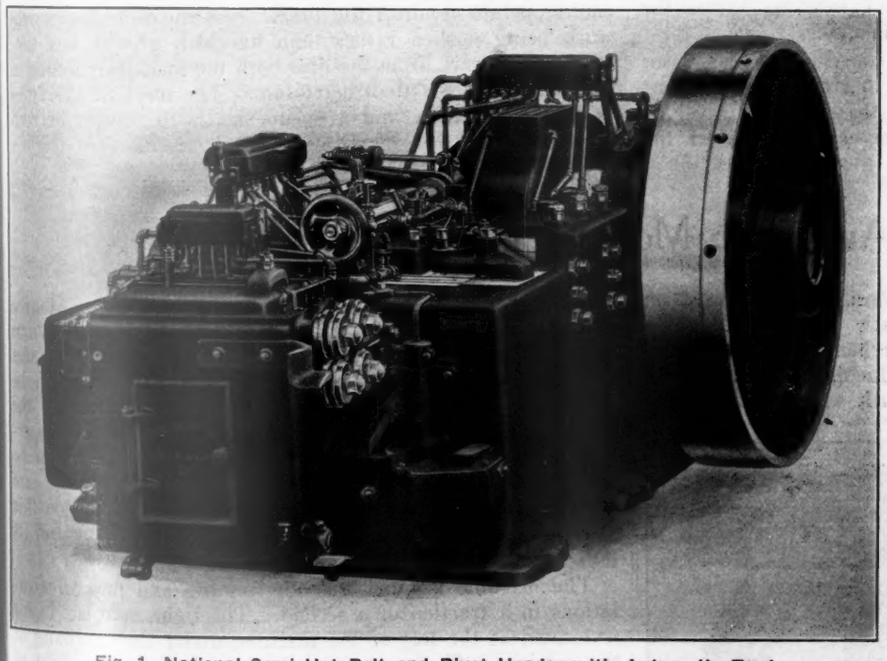


Fig. 1—National Semi-Hot Bolt and Rivet Header with Automatic Feed

One of the difficulties of the old type of machine was an inherent defect in the design of the shearing mechanism, which tended to badly distort the end of the sheared bar, making it difficult to center the next head. This condition has been corrected in the new design by building the feed mechanism at an angle to the machine proper. This gives an angling shear, illustrated in Fig. 3, which, by compensating for the distortion, results in central heads, and makes it possible to upset and fill out an increased length of stock for large, or other special heads. To assist in the control of the stock for large-head work, a bender or straightening device is regularly supplied. This is adjustable without stopping the machine and gives complete control over the centering of the stock, or the flash.

In attempting to make bolts requiring a large amount of stock, any misalinement of the heading slide causes the stock to buckle and form a defective or unfilled head. Hence, to secure better alinement in the new design, suspended heading and gripping slides of unusual length were adopted. To secure a long heading slide without the necessity of a long bed frame, the slide, which is 60 in. long, is extended up and over the crankshaft, having two separate

sets of bearings, with the location of the main shaft between (Fig. 2). This heading slide, being provided with screw adjustments for side alinement, and the heading tool or "domino" being rigidly held in the bolster plate, with a small amount of overhang, enables large heads to be made with a minimum of buckling, increasing the range of the machine. It is now possible to make U. S. square head bolts, large heads carriage bolts, New York Central square neck track bolts, Pennsylvania standard oval head track bolts, oval neck track bolts (without trimming), and a variety of large head special work heretofore considered impossible on automatic feed headers.

The powerful shearing and gripping mechanism, combined with the great strength and stiffness of the machine, enables work to be made at unusually low temperatures, resulting in a great improvement in the finish of the product, a material fuel saving, and a marked increase in die life. It is for this reason that the machine is known as a "Semi-Hot" header. Rivets are made at 1,000 to 1,100 deg. F., and bolts at 1,200 to 1,500 deg. F. Records in big bolt plants show that the life of heading tools has been doubled and of gripping dies tripled.

Consideration has also been given to every feature which would simplify the operation of the machine, reduce delays, or assist in quick changes. The bender or straightening device is adjustable without stopping the machine and the stock gage is correspondingly arranged, with a screw of such pitch that one full turn of the hand wheel gives 1/8 in. adjustment of the stock. To save delay if work is accidentally caught ahead of the dies, a wedge back of the heading tool can be relieved to get the machine "off center" easily. An automatic tripping device is also provided on the feed rod so that in case a bolt or rivet sticks in the gripping dies, the rolls are automatically raised, thus preventing the stock from continuing to feed and pile up in the dies, as frequently happened in the old type of machine before the development of the automatic tripping device.

A novel shear and face plate construction has been adopted, which, combined with the horizontal adjustment of the heading tool bolster, enables the shearing travel or "carry-over" to be adjusted. To increase the life of the shear, the water jacketing in the face plate supplies cooling water to the back of the shear, but not on the cutting edge. In order to keep the water off the bar until it reaches the shear, the feed roll spindles are made hollow and the feed rolls are water-jacketed, eliminating the necessity of running water over them and on the bar, as heretofore. Experience shows that running water on the hot bar materially increases the scaling, and results in premature deterioration of the shear and dies.

Attention has been given to every detail which would assist in maintaining high speeds. The main shaft is counterbalanced and all unnecessary weight has been removed from reciprocating parts, all of which are made of steel. A new type of "kick-out" attachment pushes the work from the dies rather than knocks it, as was customary with the old type cam-operated kicker. When the work was knocked from the dies, the blow would frequently drive it forward against the heading tool and the work would be caught by the next advancing stroke of the heading tool, before gravity could operate to drop the blank. In the new design, the work being pushed rather than knocked, gravity has time to clear the work from the dies with the machine running at even higher speeds than heretofore. The machine described is of 1-in. capacity and a 5/8-in. size is in process of construction.

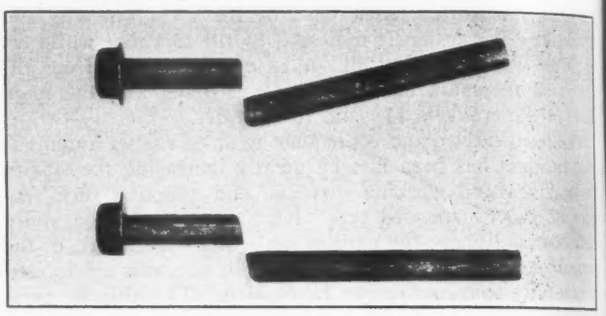


Fig. 3—Top Bolt Cut by New Angling Shear Mechanism; Bottom Bolt Cut by Old Shear

Portable Automatic Model Calculating Machine

ELECTRICALLY operated and designed to be used on either a desk or stand, the new portable automatic calculating machine illustrated has been brought out recently by the Monroe Calculating Machine Company, New York. Besides being rugged and built to stand up under long, hard usage, this new addition to the line of Monroe calculating machines is simpler to operate than previous models. There is no crank to turn; as the operator faces the machine, everything is in readiness. The keys can be depressed, carriage shifted, or dials cleared, because the handle is always in the proper location to permit these operations to be performed. There are locks but these can be disregarded because the machine automatically takes care of them. It is possible to perform every calculation on this automatic that can be performed on a hand machine and its portability is an important advantage.

Speed, Accuracy and Ease of Handling Feature This Machine

The machine is quiet, smooth running and makes calculations in a fraction of a second. The light, compact motor is located at the left of the machine under the overhang of the carriage. There are two operating bars at the right of the key board. To add, the operator simply touches the plus bar; to subtract, he touches the minus bar. The flexible key board with its automatic register and control and with an instantaneous dial clear-out, make this an extremely speedy machine. The machine also divides and multiplies automatically, giving proven answers and relieving the operator of worry and effort. A trained operator is not necessary.

Should the electric current be shut off for any reason, the Monroe Automatic can be used as a hand-operated machine

by the ready insertion of the operating crank. An ingenious mechanical control prevents locking or damage to the machine as well as safeguarding it against abuse. Monroe Automatics are furnished in two sizes; 20 place and 16 place, for either direct or alternating current, whichever is available.

During 1922, the Monroe Calculating Machine Company also brought out Fractional and British Currency Models, as additions to their regular line of machines.

Mono-Rail Hoist Designed for Low Head Room

AN electric mono-rail hoist, made in sizes from 1,000- to 12,000-lb. capacity and known as the Lo-Hed, has been placed on the market recently by the American Engineering Company, Philadelphia, Pa. In addition to the latest modern features of mono-rail electric hoist design, this hoist, illustrated in Fig. 1, is notable in that the required headroom has been reduced to a minimum. This factor will

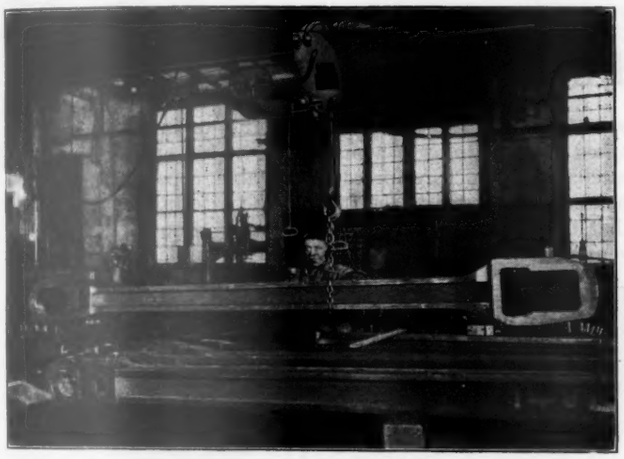


Fig. 1—The Lo-Hed Mono-Rail Electric Hoist Is Adapted to Handling Rods and Other Heavy Locomotive Parts

be appreciated from an examination of the line drawing, shown in Fig. 2, the headroom for the one-ton hoist being 10 in., and the three-ton hoist, 14 in. This feature makes the Lo-Hed hoist adaptable to use in rooms where ceilings are low, where definite headroom must be maintained for safety, and where material of large dimensions is handled. In storehouses the hoist provides a greater storage capacity because material can be stacked higher; also larger castings can be handled.

In addition to minimum headroom, this hoist has a minimum number of working parts, making a simple and durable design. All parts are readily accessible. By taking off the outside metal cover, as shown in Fig. 3, any part can be easily inspected or moved without disassembling the main body or frame of the machine. The motor can be removed while the load is on the hook. This hoist is economical in the use of power having a mechanical efficiency of over 80 per cent. A strong and durable straight spur gear drive is provided. Frictional losses are reduced by the use of Hyatt roller bearings throughout. The Alemite system of high pressure lubrication is used on all bearings not automatically lubricated by an oil bath. Many safety features are incorporated, the hoist having a factor of safety of at least five at full load.

All shafts used in this hoist are of high carbon steel, with roller bearing races pressed on the ends. The gears have accurate, machine-cut teeth, and are made from high grade forged steel. All gears are contained in the end housing,

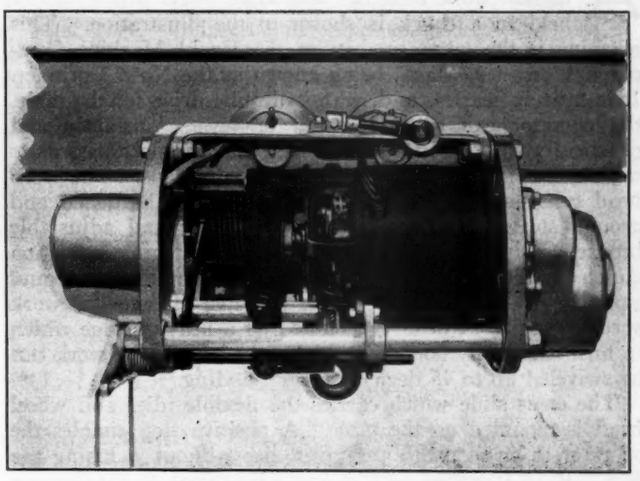


Fig. 3—Side View with Cover Removed. The Simplicity and Accessibility of Motor and Controller Are Evident

being easily removed from their shafts. A four part rope block is supplied with each hoist, these blocks having a steel yoke, provided with a forged steel hook working on a swivel.

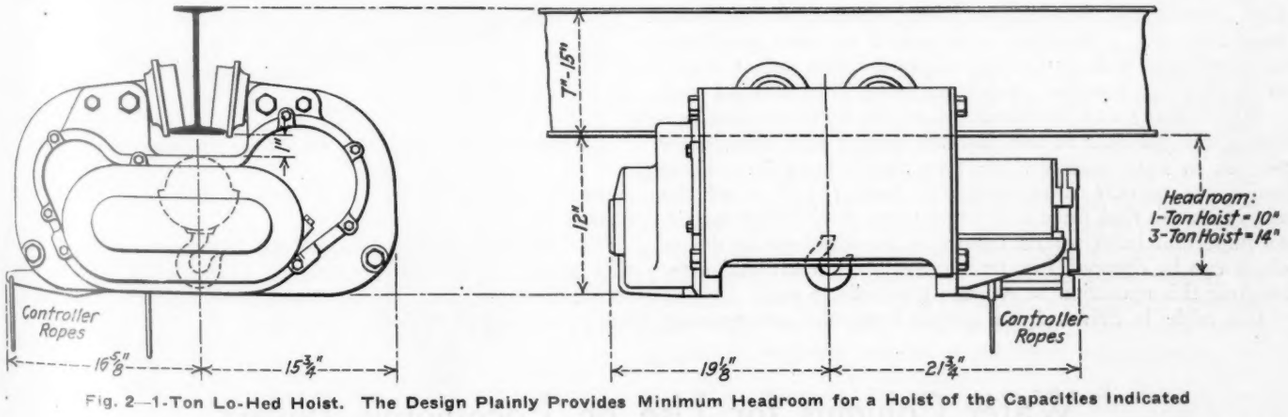


Fig. 2—1-Ton Lo-Hed Hoist. The Design Plainly Provides Minimum Headroom for a Hoist of the Capacities Indicated

The sheaves are solid-webbed, machine-grooved, fitted with proper rope guards.

The drum used in this hoist is of simple, rigid construction. The right- and left-hand cable grooves are accurately machine-turned and coil the rope in a single layer. These

drum grooves are machined to a depth sufficient to take the full diameter of the cable. The cable is connected to the exterior of the drum in a simple manner and can be easily removed or replaced. The controller used in this machine is built especially for hoist service. All parts are fireproof and are completely protected from dust and moisture. A return spring holds the controller in the "off" position. As soon as the operator releases the pull on the controller handles, the hoist stops.

The motor is of standard make, fully enclosed. All motors are equipped with high grade ball bearings and large diameter shafts. No long shaft extensions are required. Motors are fully enclosed when necessary and are guaranteed for the rated capacity of the hoist.

The automatic mechanical lowering brake runs in an oil bath and is provided to control the lowering speed. It is of the screw and disc type, geared to the intermediate shaft and having three discs. Its construction is standard and the same as used on high grade cranes.

The automatic holding brake works on a pulley mounted on the hoisting motor shaft proper and is lined with an asbestos brake band lining. It is operated by a cam on the controller shaft and holds the load safely at any point.

When the load block has reached its upper limit of travel, an automatic device serves to break the electrical circuit and apply the holding brake. This device is positive in its action, a valuable safety feature.

The Lo-Hed hoist is adapted to many uses in railroad locomotive shops, one of which is illustrated in Fig. 1. It is also a great potential labor saver in car shops, storehouses, foundries, power plants and wherever the railroads have material-handling problems.

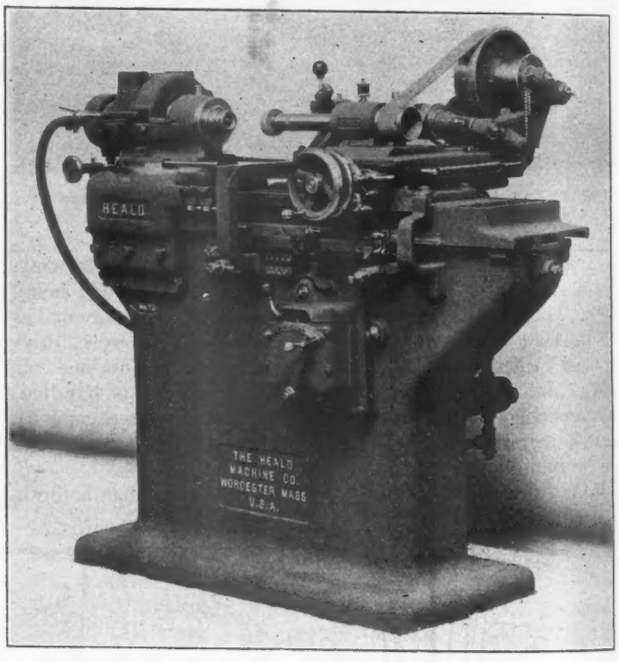
Internal Grinder with Hydraulic Table Drive

An internal grinder adapted to the grinding of hardened motion work bushings and other parts which can be held in a chuck is shown in the illustration. This machine is the latest product of the Heald Machine Company, Worcester, Mass., being known as the No. 72 grinder. It is entirely gearless and, with hydraulic drive for the table, the operator can get any speed or reverse instantly and practically without effort. The base is so proportioned as to take care of all strains and minimize vibrations. The work head consists of a massive casting having a hardened and ground steel spindle running in dust-proof and adjustable bronze bearings of ample size. A lever engaging a friction clutch on the inside of the spindle drive pulley starts and stops the water supply. There are five changes of work speed. The work head is mounted on a heavy bridge which in turn is securely bolted directly to the base. The work can be swiveled up to 45 deg. for taper grinding.

The cross slide which carries the flexible idler and wheel head is mounted on the table. A positive stop enables the operator to grind up to any given size without watching the dial. It is arranged with a fine adjustment to compensate for any wheel wear. A flexible idler with a belt tightener is mounted on the cross slide. This arrangement consists of a flexible driving pulley mounted on ball bearings, automatically keeping the belt drive taut. From this idler, power is transmitted to the wheel head by an endless belt running over a spring belt tightener that automatically takes up all the belt stress and maintains a belt wrap of 85 per cent. It also considerably reduces the side pressure on the wheel head bearing. This idler is furnished as extra equipment to interchange with any of the old style idlers and it is said to increase the possible production from 50 to 200 per cent.

Wheel heads can be furnished in 19 different sizes, enabling the operator to use just the proper size spindle for the job in hand and get the best results possible. These heads are quickly interchangeable having pulleys of the correct size so that there will be no guess work about speeds. An important labor-saving feature is the wheel-truing device which can be dropped into truing position quickly and after finishing this operation be swung up out of the way.

The table is driven by a simple hydraulic arrangement operated by oil, enabling the operator to instantly get any speed from nothing to a maximum. This hydraulic reverse mechanism, which reciprocates the table, consists of an automatic valve located at the front of the base in such a position that the operator's hand will naturally drop to it. A convenient stop is provided so that it is possible to maintain or return to any particular speed without looking at the speed change lever.



Heald Internal Grinder No. 72 for Chucking Work

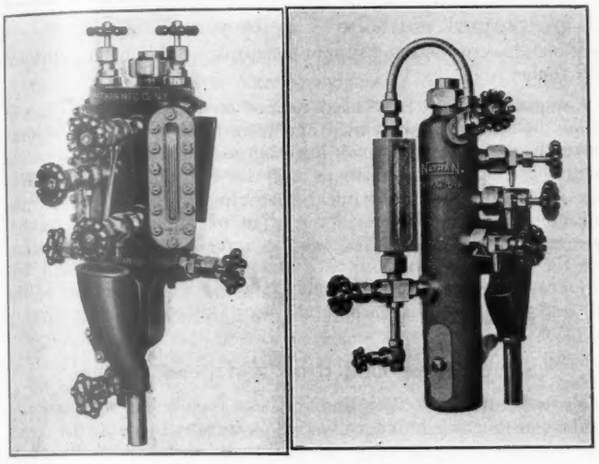
The No. 72 grinder swings work 15 in. in diameter and will grind 11 in. deep, swinging 12-in. work inside the standard water guard. The countershaft is recommended to run in a speed from 600 to 620 r.p.m.

Water Columns for Use on Locomotive Boilers

When gage cocks and water gage fittings are screwed directly into the back head of a boiler, the gage cocks sometimes indicate a higher level of water than do the water glasses. This discrepancy in the water level, as indicated by the gage cocks and the glass, is caused by the severe agitation and rapid circulation of the water through the arch tubes and up the back head. After extensive investigation by the federal boiler inspection service of the

Interstate Commerce Commission and following a number of tests on locomotives of various roads, it was recommended that the water glass and gage cock fittings be screwed to an intermediate appliance—a water column—instead of being attached directly to the boiler.

The two types of water columns illustrated are made by



Nathan Type W-B and Type W-O-A Water Columns, Fitted with Reflex and Tubular Water Glasses Respectively

the Nathan Manufacturing Company, New York, and have been tested satisfactorily under actual service conditions. The type W-O-A water column (right) with tubular glass, which complies with recommendations contained in the last annual report of the chief inspector, Bureau of Locomotive Inspection, occupies but a minimum of space on the boiler. The body of the column is drawn in at the lower end and the cross section is reduced, without, however, interfering with the necessary volume of water entering the column. By this construction the column is fitted close to the back head, with sufficient room for substantial connection to the water space of the boiler. A further variation in the bottom extension of the water column is secured by elongated pads, thus permitting of application to almost any boiler. If necessary, special lengths may be provided for any unusual installations.

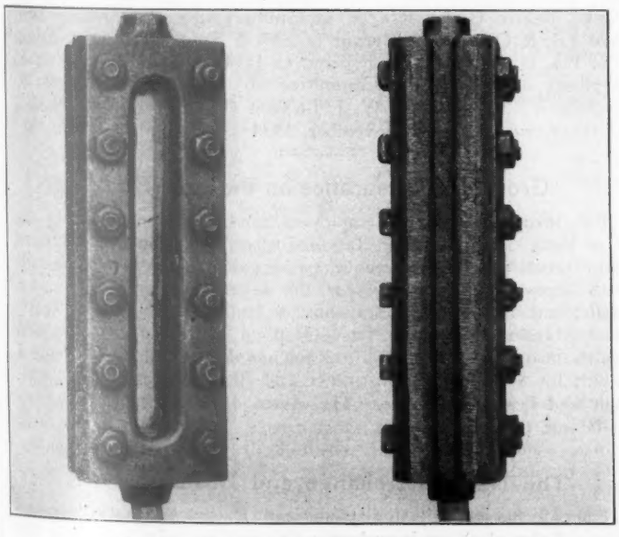
Another feature of this type is the method of attaching the gage cock to the body of the column. By doing away with the usual shank of the gage cock, the distance which the spindle of the gage cock protrudes has been materially reduced. The gage cock is so constructed that it may be removed and replaced quickly with steam in the boiler. The water gage attached to the column and the column itself are provided with necessary drain valves for draining the water gage or the column, independently of each other.

The type W-B water column (left) differs from the one previously described in that it contains two reflex gages instead of the tubular gage. This type is a self-contained water column, comprising within itself the gage cocks and the water gage, eliminating the pipe connections and joints necessary with independent water gages attached to the column. It is equipped with reflex gages, with glasses embedded in the body of the column and so placed that the water level may be observed from both the engineer's and the fireman's side.

A special provision that will be appreciated is the bonnet attached to the upper and lower valve controlling the respective water glass compartments. These bonnets are provided with warning ports which will blow at all times except when the valves are wide open.

Water Gage Glass Designed To Be Unbreakable

THE Duplex glass water gage, illustrated, is a new development recently brought out by the Duplex Glass Water Gage Company, Youngstown, Ohio. The following advantages, substantiated by actual service tests, are



Duplex Water Gage Glass for Boilers

claimed for this glass: It permits accurate reading of water level from both sides of the gage, enabling the water level to be determined by both the engineer and fireman from their respective positions in the cab. The glasses used are ½ in. thick and smooth on both sides, eliminating the possibility of corrosion which makes reading difficult. The glass will last indefinitely barring accidents and, having no intricate parts to get out of order, it can easily be assembled by anyone and kept in good operating condition. The Duplex glass embodies all the advantages of the tubular glass without its objectionable features. It eliminates the danger of flying glass in the event of breaking. It will withstand indefinite pressure and can be applied to steamboat, stationary, and other types of boilers as well as locomotive boilers. No additional illumination is required at night other than that provided for the types of glass now in use. A composition gasket, made from sheet Permanite packing is used between the glass and central metal part to make a steam tight joint.

This gage was applied to a switching locomotive in steel mill service for ten months with no maintenance or repair cost. The gaskets were renewed at the end of this period. The same gage was then applied to a railroad switching locomotive and remained in service three months with no repairs or renewals. It was removed at this time on account of the locomotive being transferred from the Youngstown territory. Each of the above tests were unofficial, being made as an experiment with the consent of the local managements.

THE LARGEST CASTING so far turned out in South Africa, weighing 50,000 lb., was recently made, according to the Ironmonger, at Salt River Works. The operation proved a complete success and when the casting was dug up, it was found to be without a flaw. It is intended for an anvil block for a three-ton hammer.

GENERAL NEWS

The Chicago, Burlington & Quincy announces that it had completed the fourth year in which no passengers have been killed in train accidents on the lines operated by the company.

Five men charged with having placed quicksilver in the boilers of Southern Pacific engines during the strike in September, were found guilty by a jury at El Paso, Tex., on January 26.

The St. Louis-Southwestern has signed wage agreements with the Association of Metal Crafts, which is an association of the railroad's employees and has no connection with the national shop craft organizations.

Sir Henry W. Thornton, K.B.E., chairman of the board of directors and president of the Canadian National, has been elected a member of the board of directors of the American Railway Association to fill a vacancy therein.

A representative of the Chicago & Alton said that the cost of the strike to his company was $1,907,990. The Alton also paid bonuses amounting to $540,000 to employees, and the Wabash spent $179,000 in the same manner. The total cost of the strike, to the seven railroads which testified at the hearing, was $14,896,000.

The Oregon-Washington Railroad & Navigation Company has been granted a permanent injunction restraining striking shopmen from interference with the company's employees or property by the United States District Court at Spokane, Wash. One picket will be permitted at each entrance to the railroad property.

The Erie Railroad car shops at Buffalo, N. Y., are now operated by the company. For about a year past they have been operated under contract by William H. Fitzpatrick, but reverted on January 30 to railroad management, in compliance with the ruling of the Railroad Labor Board. About 1,200 men have been employed by Mr. Fitzpatrick.

The cost of the shop crafts' strike last summer was the subject of inquiry at a hearing in St. Louis recently, when depositions were taken by representatives of the attorney general to be used in the appeal to the Federal court at Chicago to make permanent the temporary injunction against strike violence. E. C. Wills, assistant general manager of the Missouri Pacific, testified that the strike cost that company $2,000,000 in direct expenses and made necessary the purchase of 15 locomotives at a cost of $3,000,000.

Senator La Follette has introduced a resolution to require the Interstate Commerce Commission to report to Congress and, when Congress is not in session, to the President, monthly, the condition of railroad equipment as revealed by reports of the carriers and inspectors of the commission, the number of persons killed or injured upon the railroads and any other available data bearing on the physical condition of the railroads and their equipment, together with a statement of what action, if any, has been taken by the commission to remedy the situation.

The Dixon Construction & Repair Company, a New Jersey corporation, has asked the United States District Court at Chicago to restrain the United States Labor Board from publishing a decision, made January 6, holding null and void certain contracts between the Dixon Company and the Western Maryland Railroad. These contracts, for repairing Western Maryland cars and locomotives, were held to violate the Transportation Act, as under them Western Maryland employees were taken out from under the jurisdiction of the board and made subject to the rules of a private corporation.

The Railway & Locomotive Historical Society, 152 Harvard street, Brookline, Mass., has issued its fourth pamphlet, Bulletin No. 4, describing old stations in Boston, old locomotives of the Boston & Maine and other New England things, and "the first iron passenger cars." Two of these cars were built in 1860 by B. J. LaMothe of New York City, one for the Boston & Worcester, now a part of the Boston & Albany, and one for the Hackensack & New York, now a part of the Erie system. These cars were of sheet metal, even the floor system consisting of thin bands, stiffened with timber.

"Company unions" have been formed on the Chicago & Eastern Illinois by shopmen, signalmen and telegraphers; and, in conjunction with officers of the road, have agreed on wages and working conditions. These organizations are the Chicago & Eastern Illinois Association of Mechanical Department employees and the Chicago & Eastern Illinois Association of Signal and Telegraph Department employees. The wages agreed upon are in accord with the rulings of the United States Railroad Labor Board, but with provision for graduating the rates of pay according to the skill and experience of various classes of mechanics.

Shop Strike Ended on Northern Pacific

The strike of shopmen on the Northern Pacific has been officially ended by an overwhelming vote. The vote was taken as the result of permission given by strike leaders to the local unions to allow their members to determine for themselves whether to return to work or not. No promises of any kind have been made to the strikers, but officers of the company report that applications for work in the shops are being received in great numbers.

Relocation of New Ladders Under Standardization Rule

The Circuit Court of Appeals, Seventh Circuit, holds that when an improperly located ladder on a box car is renewed under section 3 of the Safety Appliance it must be relocated although there is no renewal of the brakes, notwithstanding the exception to the Interstate Commission's standardization rule of March 13, 1911, to the effect that brakes and ladders on such cars need not be relocated "except when such appliances are renewed."—Pennsylvania v. United States, 283 Fed. 31.

New A. R. A. Directors

The directors of the American Railway Association, chosen at the recent election, for terms expiring in November, 1925, are E. W. Beatty (C. P. R.), A. H. Smith (N. Y. C.), Daniel Willard (B. & O.), H. E. Byram (C. M. & St. P.), Howard Elliott (N. P.), B. F. Bush (M. P.) and C. H. Markham (I. C.). Two members elected to the Committee on Nominations are P. E. Crowley (N. Y. C.) and W. J. Jackson (C. & E. I.). The terms of these two expire in November, 1924.

Group Life Insurance on the New Haven

Life insurance for 7,000 employees has been arranged for by the New York, New Haven & Hartford according to an announcement made recently. This insurance, to be paid for partly by the railroad company, is provided for the benefit of employees in the mechanical and electrical transmission and communication departments. Individuals have the option of including accident and health insurance. The cost to each employee will be 60 cents a month for $1,000 of life insurance and 70 cents a month for accident and health insurance. The Aetna Life Insurance Company will issue the policies.

The New Interchange and Loading Rules

The Mechanical division, American Railway Association, announced that the new interchange and loading rules are ready for distribution. The loading rules are arranged in groups, and the rules in each group may be obtained in separate pamphlets. The groups are as follows: Group No. 1—Rules Governing the Loading of Lumber, Logs, Ties, Fence Posts, Tan Bark and Similar Products; Group No. 2—Rules Governing the Loading of Struc-

tural Material, Plates, Billets, Castings, Wheels, Pipe and Similar Products; Group No. 3—Rules Governing the Loading of Mining Cars, Engines, Boiler Shells, Machinery, Derricks and Similar Commodities; Group No. 4—Rules Governing the Loading of Concrete Culvert Pipe, Brick, Stone, Building Tile and Similar Products, and Group No. 5—Rules Governing the Loading of Automobiles.

Russian Locomotive Production Increasing

Russia will purchase no more locomotives from foreign countries, according to Berlin correspondence of the Wall Street Journal. This decision is said to be due to the fact that Russian locomotive builders have greatly increased their output. To date Soviet Russia has ordered 1,200 locomotives from foreign countries, particularly Germany and Sweden, and it is said that most of the locomotives have been delivered.

Telephone Communication Between Chicago and New York Meetings of A. I. E. E.

Simultaneous meetings of the American Institute of Electrical Engineers were held in New York and Chicago on the evening of February 14, 1923. The rooms in which the two meetings were held were connected by special telephone lines with loud speaking telephones in both auditoriums. Frank B. Jewett, president of the A. I. E. E., presided over both meetings and was assisted by R. F. Schuchardt, vice-president, in Chicago. Papers were presented alternately by speakers in New York and Chicago and duplicate lantern slides were used for illustration, the speakers calling for lantern slides by number so that the same slides would be shown in both auditoriums simultaneously. Telephonic communication was also established with broadcasting stations so that the speakers could be heard by the many people in the country who have radio receiving outfits

Cars and Locomotives Ordered

Orders placed by the railroads for freight car equipment up to February 1 called for the delivery of 91,354 cars, according to reports filed by the carriers with the Car Service Division of the American Railway Association. Orders for 23,022 freight cars were placed in January this year, while the remaining represented cars ordered but not delivered during the calendar year 1922. Coal cars under order on February 1 totaled 37,476, of which orders for 13,258 cars were placed in January. The remaining number constituted cars ordered but not delivered in 1922. Box cars on order numbered 43,211, of which orders for 7,594 were placed in January. Reports also showed that 2,082 refrigerator cars were also ordered, bringing the total number ordered but undelivered on February 1 to 6,402.

Locomotives on order on February 1 totaled 1,507 compared with 1,445 on January 1 last, or an increase of 62 for the month. Of the total number of locomotives on order, freight locomotives numbered 1,022, passenger 362 and switching, 123.

Labor Organizations Select Candidates for Labor Board Positions

The railroad labor organizations eligible to participate in the nomination of candidates for appointment to succeed Albert Phillips, whose term as a member of the labor group on the Railroad Labor Board expires on April 15, have definitely decided upon six names which will be submitted to President Harding, according to reports now being circulated from Chicago. The recommendation will include the following:

John H. Sylvester, vice-president Brotherhood of Railway Clerks; J. J. Farnum, Maintenance of Way Employees; D. W. Helt, president, Order of Railway Signalmen; Thomas Pearson, general chairman, New Haven Chapter, Order of Railway Telegraphers; G. C. Milan, Brotherhood of Railway Clerks; Albert Phillips (renomination), Brotherhood of Locomotive Firemen.

The candidacy of John H. Sylvester was favored, it is said, by a majority of the representatives of the larger unions, although a certain strong faction, particularly among the train service organizations, was said to favor the reappointment of Phillips. The Sylvester appointment is said to find favor by reason of the fact that Mr. Sylvester is a representative of Group 2 among the standard organizations, whereas W. L. McMenimen and Albert Phillips are the spokesmen of the Group 1 unions, Group 3 being already represented by A. O. Wharton, whose term expires in 1927, while Group 2 is minus a spokesman on the Board.

Canadian Pacific's Program for 1923

An extensive program of improvements to be undertaken by the Canadian Pacific includes a number of betterments in engine terminals and shop equipment.

Coaling plants of the latest type will be built at Ignace and Kenora, Ont.; Winnipeg, Man.; Estevan, Sask., and Red Deer, Alta.

An extension will be made to the enginehouse at Hardisty, Alta., and extensive improvements made to the mechanical plants at Weston (Ont.) shops, Neudorf, Sask.; Reston, Sask.; Minnedosa, Man.; Broadview, Regina, Sask.; Calgary, Alta., and Alyth, Alta.

Steel water tanks of from 60,000 to 100,000 gal. capacity will be built at McAdam Junction, N. B., and in Ontario at Guelph Junction, Nemegos, Markstay, and Grassett, and at St. Johns, Que.

Modern coaling plants will be constructed at Megantic, Que., and Jackfish, Ont., and a 90-ft. turntable to handle heaviest power will be installed at MacTier, Ont.

Additional mechanical and car department equipment will be provided at Hochelaga, Glen Yard and Place Viger, P. Q., and Smiths Falls, Toronto, and North Bay, Ont.

MEETINGS AND CONVENTIONS

Division VI—Purchases and Stores

Division VI—Purchases and Stores—of the American Railway Association will hold its annual meeting in Chicago on May 15, 16 and 17, 1923. Headquarters will be at the Hotel Sherman.

Air Brake Association—Pike's Peak Trip

In connection with the annual convention at Denver, May 1-4, announcement has been made that the management of the Manitou & Pike's Peak railroad are willing to open the road on May 4, instead of the usual date, May 15, and thus permit those attending the convention to make the trip to the summit of this famous mountain. In order that this may be done, it will be necessary to assure a party of 100. The rate of fare will be $4. Those who wish to take this trip should notify the secretary.

International Railway General Foremen's Association

Announcement has been made that the 1923 annual convention will be held at Hotel Sherman, Chicago, September 4 to 7 inclusive. The following topics will be discussed:

Shop Efficiency, Locomotive and Car Departments. Chairman, F. M. A'Hearn, Greenville, Pa.

a.—Apprentices, training and developing.
b.—Relation of foremen and employees.
c.—Methods of increasing efficiency of supervisors and employees.
d.—Discipline.
e.—Increased output per man-hour; costs.

Welding Flanges on Driving Tires, Engine Truck and Tender Wheel Tires. Chairman, H. T. Cromwell, Baltimore, Md.

General Repair Methods and Maintenance. Chairman, J. H. Frizell, Topeka, Kans.

a.—Valves, valve gears and power reverse gears.
b.—Engine, tender and car trucks.
c.—Air brake appliances on passenger and freight equipment.

General Repair Methods and Maintenance. Chairman, W. S. Buntain, Battle Creek Stokers, Coal Pushers and Air Firedoors.

Shop Kinks, Locomotive and Car Departments. Chairman, Geo. H. Logan, Chicago, Ill.

Symposium on Locomotive Terminal Design

The Western Society of Engineers, Chicago, will present a symposium on locomotive terminal design at its rooms in the Monadnock building on Tuesday evening, March 13. L. K. Sillcox, general superintendent of motive power of the Chicago, Milwaukee & St. Paul, will discuss the subject from the standpoint of the mechanical department; R. N. Begien, general manager of the Baltimore & Ohio, Western lines, will outline the

requirements of the operating department; and W. T. Krausch, engineer of buildings, of the Chicago, Burlington & Quincy, will describe the manner in which the engineering department meets these requirements.

Fuel Association Convention Program

Julius Kruttschnitt, chairman of the executive committee of the Southern Pacific, will deliver the opening address at the convention of the International Railway Fuel Association to be held at the Hotel Winton, Cleveland, Ohio, on May 21-24. An address will also be made by T. K. Maher, president of the Maher Collieries Company. A partial list of the papers to be presented is as follows: "Extension of Locomotive Runs," by C. B. Peck, associate editor, *Railway Mechanical Engineer;* "Considerations Covering Use of Oil as a Locomotive Fuel," by M. C. M. Hatch, mechanical engineer, M. K. & T.; "Fuel Saving Aspect of Boiler Water Treatment," by C. R. Knowles, superintendent water service, Illinois Central; "Value of Individual Fuel Performance Records," by L. G. Plant, editor, Railway Review; "Standardization of the Coal Business," by Geo. H. Cushing; "The Other Ten Per Cent," by R. S. Twogood, assistant engineer, Southern Pacific; "Economic Aspects of the Fuel Oil Situation," by C. E. Beecher, U. S. Bureau of Mines; "Economy in the Heating of Stations and Buildings," by Prof. R. W. Noland, Purdue University; "Incentives for Promoting Fuel Economy," by O. S. Buyer, Jr.

There will also be a topical discussion of the paper on the effect of tonnage rating and speed on fuel consumption presented by J. E. Davenport at the 1922 convention.

The following list gives names of secretaries, dates of next or regular meetings and places of meeting of mechanical associations and railroad clubs:

Air-Brake Association.—F. F. Nellis, Room 3014, 165 Broadway, New York City. 1923 annual convention; Denver, May 1 to 4 inclusive.

American Railroad Master Tinners', Coppersmiths' and Pipefitters' Association.—C. Borcherdt, 202 North Hamilton Ave., Chicago.

American Railway Association, Division V—Mechanical.—V. R. Hawthorne, 431 South Dearborn St., Chicago. Annual meeting, Chicago, beginning June 20, 1923.

Division V—Equipment Painting Division.—V. R. Hawthorne, Chicago.

Division VI—Purchases and Stores.—W. J. Farrell, 30 Vesey St., New York. Next meeting, Chicago, May 22, 1923. Annual meeting, Hotel Sherman, Chicago, May 15, 16 and 17, 1923.

American Railway Tool Foremen's Association.—R. D. Fletcher, 1145 E. Marquette Road, Chicago.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. Thirty-ninth St., New York. Railroad Division, A. F. Stuebing, 2201 Woolworth Building, New York.

American Society for Testing Materials.—C. L. Warwick, University of Pennsylvania, Philadelphia, Pa. Annual meeting, Chalfonte-Haddon Hall Hotel, Atlantic City, N. J., beginning June 25, 1923.

American Society for Steel Treating.—W. H. Eiseman, 4600 Prospect Ave., Cleveland, Ohio.

Association of Railway Electrical Engineers.—Joseph A. Andreucetti, C. & N. W., Room 411, C. & N. W. Station, Chicago, Ill.

Canadian Railway Club.—W. A. Booth, 53 Rushbrook St., Montreal, Que.

Car Foremen's Association of Chicago.—Aaron Kline, 626 N. Pine Ave., Chicago, Ill. Meeting second Monday in month, except June, July and August, Great Northern Hotel, Chicago, Ill.

Car Foremen's Association of St. Louis.—Thomas B. Koeneke, 604 Federal Reserve Bank Building, St. Louis, Mo.

Central Railway Club.—H. D. Vought, 26 Cortlandt St., New York, N. Y. Next meeting March 8, Iroquois Hotel. A paper entitled "Fundamentals of Train Control with Special Reference to Railway Operating Conditions" will be presented by F. J. Dodgson, consulting engineer, General Railway Signal Company.

Chief Interchange Car Inspectors' and Car Foremen's Association.—W. P. Elliott, T. R. R. A. of St. Louis, East St. Louis, Ill.

Cincinnati Railway Club.—W. C. Cooder, Union Central Building, Cincinnati, Ohio.

International Railroad Master Blacksmiths' Association.—W. J. Mayer, Michigan Central, 2347 Clark Ave., Detroit, Mich.

International Railway Fuel Association.—J. G. Crawford, 702 East Fifty-first St., Chicago, Ill. Next meeting, May 21-24, 1923, Cleveland, Ohio.

International Railway General Foremen's Association.—William Hall, 1061 W. Wabash Ave., Winona, Minn. Annual convention, Hotel Sherman, Chicago, September 4-7, 1923.

Master Boilermakers' Association.—Harry D. Vought, 26 Cortlandt St., New York, N. Y. Annual convention, Hotel Fuller, Detroit, Mich., May 22 to 25 inclusive, 1923.

New England Railroad Club.—W. E. Cade, Jr., 683 Atlantic Ave., Boston, Mass.

New York Railroad Club.—H. D. Vought, 26 Cortlandt St., New York.

Niagara Frontier Car Men's Association.—George A. J. Hochgreb, 623 Brisbane Building, Buffalo, N. Y.

Pacific Railway Club.—W. S. Wollner, 64 Pine St., San Francisco, Cal. Next meeting University Club of California, Berkeley, March 8. A paper entitled "As to the Locomotive, What Next" will be presented by G. M. Basford.

Railway Club of Pittsburgh.—J. D. Conway, 515 Grandview Ave., Pittsburgh, Pa.

St. Louis Railway Club.—B. W. Fruenthal, Union Station, St. Louis, Mo.

Traveling Engineers' Association.—W. O. Thompson, 1177 East Ninety-eighth St., Cleveland, Ohio.

Western Railway Club.—Bruce V. Crandall, 605 North Michigan Ave., Chicago.

SUPPLY TRADE NOTES

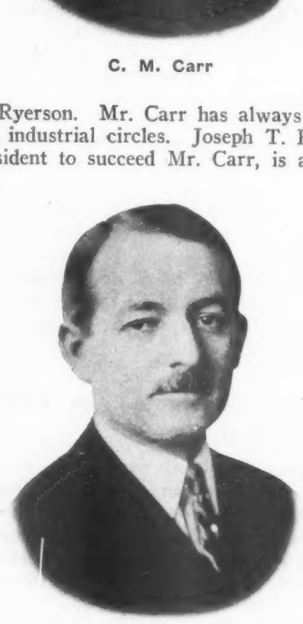
J. J. Otley, president of the Otley Paint Manufacturing Company, Chicago, died on January 20 from cerebral hemorrhage, at Chicago.

Thomas W. Delanty has joined the sales organization of the Prime Manufacturing Company, manufacturers of locomotive and car specialties, Milwaukee, Wis.

The Uehling Instrument Company, Paterson, N. J., has appointed the Mine & Smelter Supply Company of El Paso, Texas, as its exclusive representatives for CO_2 recording equipment and other power plant recording instruments in Arizona, New Mexico, west Texas and Mexico north of Mexico City.

Clyde M. Carr has retired as president of Joseph T. Ryerson & Son, Inc., but will continue as a director. On account of poor health, Mr. Carr has been unable to take an active part in the management of the firm for the past two years. At the annual meeting of the directors, Joseph T. Ryerson was elected president. Mr. Carr was born in Will county, Illinois, in 1869. He attended Lake Forest Academy and was later a student at Northwestern University for two years. He first became associated with Joseph T. Ryerson & Son, Inc., in 1890, and has taken an active part in the management of the firm's affairs. Mr. Carr served as vice-president until 1911, when he was elected president of the corporation to succeed Edward L. Ryerson. Mr. Carr has always been an active leader in civic and industrial circles. Joseph T. Ryerson, who has been elected president to succeed Mr. Carr, is a grandson of the original Joseph T. Ryerson, who founded about 1842 the business which was incorporated under its present name in March, 1883. The new president has been for 22 years in the steel business. He was born in Chicago in 1880, and immediately after graduating from Yale in 1901 went to work for the American Sheet Steel Company, now the American Sheet & Tinplate Company, at its mill in Vandergrift, Pa. In October, 1902, he entered the service of Joseph T. Ryerson & Son, Inc., at Chicago, and in 1904 was elected treasurer, becoming vice-president in 1911. Mr. Ryerson is actively interested in the National Chamber of Commerce and other general industrial work.

C. M. Carr



Joseph T. Ryerson

The American Bolt Corporation, with headquarters at 17 Battery Place, New York City, has been organized and is a consolidation of the Bayonne Bolt & Nut Company, Bayonne, N. J., the Boss Nut Company, Chicago, Ill., the Standard Bolt Corporation, Columbus, Ohio, and the Michigan Bolt & Nut Works, Detroit, Mich. Justin C. Burns is chairman of the board, at Columbus, Ohio; J. Rich Steers, president, New York City;

Frank S. Bigler, Detroit, Mich.; C. L. Rupf, New York City; J. A. MacLean, Chicago, and R. H. Hill, Detroit, Mich., are vice-presidents. Harley E. Burns is secretary and treasurer, Columbus, Ohio. The company manufactures Boss nut locks, also a complete line of bolt and nut products.

S. I. Hopkins, representative of the Safety Car Heating & Lighting Company, with headquarters at St. Louis, Mo., has been promoted to manager of the St. Louis office.

Michael J. O'Connor has been appointed a special railroad representative of William H. Keller, Inc., Grand Haven, Mich., manufacturers of Keller pneumatic tools. Mr. O'Connor's territory will cover the section of the country situated east of Chicago and his headquarters will be at 631 Fulton building, Pittsburgh, Pa. He is an old railroad man, having served as a locomotive engineman on the Cincinnati, Hamilton & Dayton for twenty years. After leaving railroad work he accepted a position with the Chicago Pneumatic Tool Company, with whom he was employed for four years and after that was connected for six years with the Ingersoll-Rand Company, whom he left to take up his new work.

M. J. O'Connor

The first locomotive to be built on the Pacific Coast was recently completed by the Willamette Iron & Steel Works at Portland, Ore. The locomotive is of the geared type and will be used for logging purposes.

W. P. Thomas, road foreman of engines of the Minneapolis & St. Louis, at Marshalltown, Iowa, has been appointed service engineer of the Franklin Railway Supply Company, Inc., New York.

W. H. Holtom, road foreman of engines of the Michigan Central at Jackson, Mich., has been appointed service engineer of the Franklin Railway Supply Company, Inc., New York.

William G. Willcoxson, formerly with the Boss Nut Company, has joined the sales organization of the Gold Car Heating & Lighting Company, Brooklyn, N. Y. Mr. Willcoxson will have his headquarters at Chicago, Ill.

H. E. Seifried, secretary-treasurer of the Stone Franklin Company, St. Louis, Mo., has been appointed assistant to the vice-president of the Franklin Railway Supply Company, Inc., Chicago, succeeding H. M. Clawson, resigned.

The Sommer-Adams Company, Cleveland, Ohio, recently incorporated, has taken over the line of milling cutters formerly made by the Cleveland Milling Machine Company, and will also manufacture special tools, jigs and fixtures.

The Globe Steel Tube Company, Milwaukee, Wis., has opened a southeastern district sales office at 716 Continental building, Baltimore, Md., and R. R. Lally, formerly of the National Tube Company, has been appointed district sales agent.

The Combustion Engineering Corporation, New York City, has acquired the Quinn Oil Burner & Torch Company also of New York City. W. R. Quinn, former president of the Quinn Company, becomes associated with the Combustion Engineering Corporation as manager of its fuel oil department.

The American Locomotive Company and the General Electric Company have entered into an arrangement providing for close cooperation between the engineering organizations and manufacturing facilities of the two companies, in the design and manufacture of electric locomotives for use on steam or electric railways.

At the annual meeting of the Brake Beam Manufacturers' Institute at the Union League Club, Chicago, on January 18, the following officers were elected: J. H. Slawson, vice-president of the Republic Railway Equipment Company, Inc., was re-elected president; A. H. Peycke, manager of the brake beam department of the American Steel Foundries, was elected vice-president, and F. T. DeLong, vice-president and sales manager of the Chicago Railway Equipment Company, was re-elected treasurer.

L. K. Berry resigned as domestic sales manager of the Warner & Swasey Company, Cleveland, Ohio, on February 1, to become sales manager of the Detroit Twist Drill Company, Detroit, Mich. He will be succeeded by C. J. Stilwell, foreign sales manager, whose jurisdiction will cover both foreign and domestic sales.

Harry A. Pike has been appointed railway representative of the Standard Engineering & Lubricating Company, New York, manufacturers of Triplex water and metal treatment and Beltcling lubricator. Mr. Pike began railroad work in 1880 as general storekeeper of the Lake Erie & Western in Lima, Ohio, now part of the New York Central lines. In 1883 he was appointed chief clerk in the motive power department of the Chicago & Atlantic, now a part of the Erie. In 1885 he was made a representative of the American Brake Company at St. Louis, and three years later went to the U. S. Metallic Packing Company in the same capacity, with offices in Chicago. In 1893 he was appointed a representative of the Chicago Pneumatic Tool Company, and in 1904 was made eastern sales manager of the Flannery Bolt Company, with offices in New York City. After severing his connection with that company he was associated with a number of industrial and other concerns, now returning to the railway supply interests.

At the annual meeting of the Pollak Steel Company, Cincinnati, Ohio, Emil Pollak, for many years president, was elected chairman of the board of directors. Maurice E. Pollak, formerly vice-president, was elected president. Julian A. Pollak was re-elected vice-president, with headquarters at Cleveland, and Edward J. Schriever was re-elected secretary. Edgar Johnson has been elected a director, and Charles Judah, treasurer, was elected to the board of directors to fill the vacancy caused by the retirement of Bernard E. Pollak, formerly vice-president. D. E. Sawyer has retired as general sales manager. The general sales management of the company, formerly handled in the New York office, will be conducted from Cincinnati, but the company will maintain a sales office in the Equitable building, New York City, with Clyde F. Hicks as eastern representative. Maurice E. Pollak was born at Cincinnati, Ohio, and has lived there all his life. He attended the public school, Franklin preparatory school and the University of Cincinnati. On leaving the university he went into business with his father, Emil Pollak, and served his apprenticeship in the shops at Cincinnati, and later became superintendent of that plant, which position he held for several years. In the reorganization of the company in 1911, when the Pollak Steel Company was formed, the Pollak interests took over the Cincinnati plant from the old company, the Block Pollak Iron Company, and Maurice E. Pollak was then elected vice-president in charge of operations. The Cincinnati plant was extended during 1915, 1916 and 1917, and the Chicago plant was acquired in 1916, and has since grown in size. In 1919 the Pollak Steel Company purchased the plant of the Interstate Iron & Steel Company at Marion, Ohio, thereby acquiring another addition to its already large properties.

M. E. Pollak

The Walworth Manufacturing Company, Boston, Mass., has organized the Walworth Ohio Company, with general office at Cleveland, Ohio, to be conducted as a branch of the Walworth Manufacturing Company. The new company has taken over the business and property of the Hiram Rivitz Company of Cleveland. S. R. Mitchell, manager of the Kewanee Works of the Walworth Manufacturing Company, has been appointed vice-president and general manager at Cleveland of the new Walworth unit and will take active charge of the Walworth Ohio Company.

TRADE PUBLICATIONS

Seamless Boiler Tubes.—Bulletin No. 12, covering the properties, use and manufacture of Shelby seamless hot rolled boiler tubes, is a valuable addition to the series of bulletins issued by the National Tube Company, Pittsburgh, Pa. The details of manufacture are clearly described and the text is accompanied by many illustrations. In addition to information in regard to physical and chemical properties and tests there are a number of tables covering tubes ranging from 2-in. to 6-in. diameter which are of value to users of such material.

Coaling Plants.—The Howlett Construction Company, Moline, Ill., has issued a booklet containing line drawings and photographic illustrations of various types of coaling equipment it has recently built for railways, together with illustrations and specifications concerning its line of hoists, car pullers, coaling aprons and other machinery adapted for this use. The principal coaling stations illustrated are concrete plants built for the St. Louis-San Francisco and the Louisville, Henderson & St. Louis, and frame plants built for the Great Northern and the Illinois Central.

The American Society for Testing Materials has published in pamphlet form a list of alloys which is taken from the report of the Committee on Non-Ferrous Metals and Alloys presented at the last annual meeting of the society. This list contains the chemical composition of approximately 1,500 alloys, divided into 17 groups, the alloys in each group being arranged alphabetically. Among the important alloys listed are 275 of brass, 260 of bronze, 165 of nickel silver, 140 of aluminum, 130 of tin base and 105 of lead base.

Oil Burners.—F. J. Ryan & Company, Philadelphia, Pa., has just issued bulletin 1B entitled "Mircs Oil Burners," containing a large amount of information of value to industrial users of oil-burning equipment. Essential factors in the efficient burning of fuel oil are pointed out; also the effect of relative air and oil pressures. Two sets of curves are illustrated from which the correct size of burner and necessary amounts of air needed for correct combustion can be determined. Details regarding the construction and operation of the Mircs burner are also included.

Applying Science to Inhibit Rust.—This is the title of a booklet just issued by the Dearborn Chemical Company, Chicago, describing No-Ox-Id, a recently developed compound for use in protecting iron and steel surfaces against rust. A wide range of applications for the compound, which not only protects by providing a surface covering but chemically inhibits the tendency toward corrosion under the ordinary protective coating, are set forth in the booklet, together with directions for its application by dipping, brushing or spraying, under a wide range of conditions.

Lifting Magnets.—Publication 3015, distributed by the Cutler-Hammer Manufacturing Company, Milwaukee, Wisconsin, is an illustrated 24-page booklet describing C-H Red lifting magnets. The advantages of these high duty lifting magnets are explained, with particular emphasis on important features of construction. Full construction details are given. A large number of clear-cut, interesting illustrations show the adaptability of C-H magnets to many industrial fields. Performance data and resultant savings on some of the installations are given; also operating costs. Lists showing the lifting capacity and ratings of the different sizes of C-H high duty lifting magnets are included. The booklet will be of interest to all confronted with metal scrap or material handling problems.

Feed Water Treatment.—The scientific handling of serious water problems confronting both railroad and industrial users of steam boilers is the subject of a brief but forceful little booklet recently issued by the Dearborn Chemical Company, Chicago. This booklet shows how the Dearborn organization, with 35 years' experience in treating feed water, goes into the matter for its clients from every angle, including (1) the complete mineral analysis; (2) study of plant equipment and operating conditions; (3) expert advice and assistance from the standpoint of practical power production engineering; (4) followed up with laboratory control after treatment is installed, the water being analyzed from time to time and the material adjusted to suit changing conditions that may develop.

EQUIPMENT AND SHOPS

Locomotive Orders

The Norfolk Southern has ordered 4 Consolidation type locomotives from the Baldwin Locomotive Works.

The Chicago Junction has ordered 5, 0-8-0 type switching locomotives from the Lima Locomotive Works.

The New York, Chicago & St. Louis has ordered 30 Mikado type locomotives from the Lima Locomotive Works.

The Lehigh & New England has ordered three 2-8-0 type locomotives from the American Locomotive Company.

The Central of New Jersey has ordered 10 Mikado type locomotives from the American Locomotive Company.

The New York, Ontario & Western has ordered 6 Mountain type locomotives from the American Locomotive Company.

The Denver & Rio Grande Western has ordered 20 Mikado locomotives from the American Locomotive Company.

The Oliver Iron Mining Company has ordered 12, 8-wheel switching locomotives from the American Locomotive Company.

The Republic Iron & Steel Company has ordered 5, 0-8-0 type switching locomotives from the Baldwin Locomotive Works.

The Quebec Development Company, Charlotte, N. C., has ordered from the American Locomotive Company 14, 4-wheel tank engines.

The Chicago, Rock Island & Pacific has ordered 30 Mikado type and 10 Mountain type locomotives from the American Locomotive Company.

The New York Central will have repairs made to from 25 to 50 Consolidation and Mikado type locomotives at the Beach Grove, Ind., shops.

The Mobile & Ohio has ordered 10 Mikado type locomotives from the Lima Locomotive Works and 3 Pacific type locomotives from the Baldwin Locomotive Works.

The New York Central has ordered for the Indiana Harbor Belt 10 Mikado type locomotives from the Lima Locomotive Works and 10 Mikado type from the American Locomotive Company.

The Buffalo, Rochester & Pittsburgh has ordered 5 Pacific type passenger locomotives, 9, 0-8-0 type switching locomotives, 14, 2-6-6-2 Mallet type and 2, 2-8-8-2 Mallet type locomotives from the American Locomotive Company.

The Pennsylvania Railroad has placed orders with the Baldwin Locomotive Works for the construction of 275 engines for heavy freight service, delivery to be made before November 1, next. This number includes 75 locomotives not hitherto allotted out of a total authorization of 300, approved by the board of directors on January 10. It also includes a new and additional authorization of 200, making altogether 500 new locomotives ordered by the Pennsylvania Railroad System since the first of the year. Delivery is just being completed of an order for 100 heavy freight engines placed with the Baldwin Locomotive Works last August. All of the new locomotives now ordered and under construction will be used to replace others of lighter and inferior types which are to be retired from service.

Passenger Car Orders

The Union Pacific has ordered 10 horse baggage cars from the American Car & Foundry Company.

The Union Pacific has ordered 10 steel dining cars and 8 steel observation cars from the Pullman Company.

The Central of New Jersey has ordered three baggage and mail cars from the American Car & Foundry Company.

The Central Vermont will have 8 coaches and 2 baggage cars built at the Port Huron, Mich., shops of the Grand Trunk.

The Buffalo, Rochester & Pittsburgh has ordered 7 coaches, 3 baggage and mail and 6 baggage cars from the American Car & Foundry Company.

THE WESTERN PACIFIC has ordered 20 coaches and 8 dining cars from the Pullman Company and 20 baggage cars from the Pressed Steel Car Company.

THE CANADIAN PACIFIC has ordered 12 combination mail and baggage cars, 6 cafe parlor car frames and 6 buffet car frames from the Canadian Car & Foundry Company.

THE ERIE RAILROAD has increased its accommodations for suburban passengers to and from New York City by the purchase of 14 Pullman sleeping cars which have been converted into day coaches. The cars will seat 84 passengers each.

Freight Car Orders

SWIFT & Co. is building 200 refrigerator cars in its own shops.

THE LION OIL COMPANY has ordered 100 tank cars from the Chicago Steel Car Company.

THE GULF REFINING COMPANY has ordered 100 tank cars from the Standard Steel Car Company.

THE TEXAS COMPANY has ordered 100 tank cars from the General American Tank Car Corporation.

THE MINARETS & WESTERN has ordered 200, 40-ton flat cars from the Pacific Car & Foundry Company.

THE GREAT NORTHERN has ordered 125 tank cars of 12,500 gal. capacity from the Chicago Steel Car Company.

THE CENTRAL OF NEW JERSEY is having 200 box cars repaired at the shops of the Standard Steel Car Company.

THE INTERSTATE RAILROAD has ordered 500 hopper cars of 55 tons' capacity from the Pressed Steel Car Company.

THE SOUTHERN LUMBER COMPANY, Warren, Ark., has ordered 125, 50-ton logging cars from the Bettendorf Company.

THE ILLINOIS CENTRAL has ordered 50, 30-yd. air dump cars from the Western Wheeled Scraper Company, Aurora, Ill.

THE CANADIAN NATIONAL has ordered 100 general service cars of 50 tons' capacity from the Pressed Steel Car Company.

THE MOBILE & OHIO has ordered 400 box cars, 100 stock cars and 200 hopper cars from the American Car & Foundry Company.

THE HILLMAN COAL COMPANY, Pittsburgh, Pa., has ordered 300 steel hopper cars of 55 tons' capacity from the Standard Steel Car Company.

THE GREAT NORTHERN has divided equally an order for 1,500 ore cars between the Pressed Steel Car Company and the Cambria Steel Company.

THE CANADIAN NATIONAL has ordered 400 automobile cars from the National Steel Car Corporation, Ltd., and 600 from the Canadian Car & Foundry Company.

THE SOUTHERN PACIFIC has ordered 575, 50-ton general service cars from the Ralston Steel Car Company and is having 500 logging cars built in the shops of its Pacific system.

THE ATLANTIC COAST LINE has ordered from the Virginia Bridge & Iron Company 500 sets of steel underframes and superstructures for box cars to be built in its own shops.

THE NEW YORK, CHICAGO & ST. LOUIS has ordered 1,000 composite hopper cars from the Pressed Steel Car Company and 500 composite gondola cars from the Standard Steel Car Company.

THE BUFFALO, ROCHESTER & PITTSBURGH has ordered 50 caboose cars from the Standard Steel Car Company. This company has also placed an order for 25 extension side dump cars with the Clark Car Company.

THE CANADIAN PACIFIC has ordered 300 steel underframe flat cars from the Eastern Car Company, 300 gondola cars from the Canadian Car & Foundry Company and will build 50 tank cars in the Canadian Pacific's shops.

THE SOUTHERN PACIFIC has ordered 3,700 box cars from the Standard Steel Car Company, 350 flat from the Ralston Steel Car Company, 550 stock from the Pullman Company. The railroad company will build 300 flat cars and 100 caboose cars in its own shops.

THE ELGIN, JOLIET & EASTERN has ordered 200 all-steel hopper cars from the Mount Vernon Car Manufacturing Company, 100 all-steel hopper cars and 100 composite gondola cars from the Pressed Steel Car Company; all of the above cars are of 70 tons' capacity. Orders were also placed for 200 composite gondola cars with the Pullman Company and for 200 composite gondola cars with the Standard Steel Car Company.

THE ILLINOIS CENTRAL has ordered 125 caboose cars from the American Car & Foundry Company, 1,750 composite gondola cars from the Pullman Company, 750 from the General American Car Company and 500 each from the Bettendorf Company and the Keith Car & Manufacturing Company.

Machinery and Tools

THE SEABOARD AIR LINE has ordered 2, 30-in. lathes from Joseph T. Ryerson & Son.

THE MICHIGAN CENTRAL has ordered an 800-lb. hammer from the Niles-Bement-Pond Company.

THE NORFOLK & WESTERN has ordered a 2,000-lb. hammer from the Niles-Bement-Pond Company.

THE ILLINOIS CENTRAL has ordered one 150-ton wrecking crane from the Industrial Works, Bay City, Mich.

THE SOUTHERN PACIFIC has ordered a 400-ton double-end wheel press from the Niles-Bement-Pond Company.

THE TRANS-MISSISSIPPI TERMINAL has ordered one set of bending rolls from the Niles-Bement-Pond Company.

THE BALDWIN LOCOMOTIVE WORKS has ordered 2 horizontal rod milling machines from the Niles-Bement-Pond Company.

THE DENVER & RIO GRANDE WESTERN has ordered one 75-ton wrecking crane from the Industrial Works, Bay City, Mich.

THE DENVER & SALT LAKE has ordered one 500-lb. Bradley hammer from the Herr Rubincam Supply Company, Denver, Colo.

THE NORTHERN PACIFIC has ordered a 30-in. planer, a 36-in. planer, and a 48-in. planer; also a 100-ton bushing press from the Niles-Bement-Pond Company and several other tools.

Shops and Terminals

CHICAGO & NORTH WESTERN.—This company contemplates the construction of a new shop building at Madison, Wis.

NORTHERN PACIFIC.—This company contemplates the construction of a boiler shop at Livingston, Mont., reported to cost approximately $150,000.

ST. LOUIS-SAN FRANCISCO.—This company has awarded a contract for the construction of a roundhouse at Muskogee, Okla., to C. E. Hamilton of St. Louis, Mo.

MISSOURI PACIFIC.—This company has awarded a contract to J. J. Wuellner & Son, Alton, Ill., for the construction of a 147-ft. by 201-ft. brick machine shop at Ewing avenue, St. Louis, Mo.

ATCHISON, TOPEKA & SANTA FE.—This company contemplates the construction of two new roundhouses, a car repair house and extensive yard improvements at Emporia, Kan., to cost approximately $5,000,000.

ATCHISON, TOPEKA & SANTA FE.—This company has authorized the following construction work at Emporia, Kan.: One 120-ft. turntable, a 43-stall roundhouse, a 1,000-ton coal chute, cinder pits, oil and water crane with necessary tracks, a blacksmith building, lavatory and roundhouse office building and car repair yard facilities.

PERE MARQUETTE.—This company has awarded a contract to Battey & Kipp, Chicago, for the construction of a 30-stall roundhouse, a 100-ft. electrically operated turntable, a concrete coaling station and sandhouse, a water tank, a cinder pit and related facilities. When completed the facilities will also be used by the Wabash and the Pennsylvania.

GREAT NORTHERN.—This company will construct a 30-ft. by 450-ft. addition to its woodworking shop and a 600-ft. monitor on its car repair shed at Great Falls, Mont., to cost approximately $42,000. Bids will be called for about March 1. The company is also calling for bids for the construction of a 145-ft. by 300-ft. addition to the car repair shop at St. Cloud, Minn., to cost approximately $100,000.

PERSONAL MENTION

General

E. C. Howerton, master mechanic Denver & Rio Grand Western at Alamosa, Colo., has been appointed general mechanical inspector, succeeding J. C. Brown.

H. M. Ray, personnel assistant of the Kansas City Southern, with headquarters at Kansas City, Mo., has been appointed personnel supervisor, with the same headquarters.

J. Butler, master mechanic of the Ann Arbor, with headquarters at Owosso, Mich., has been promoted to superintendent of motive power, with the same headquarters.

O. M. Davison, wage supervisor of the Kansas City Southern, with headquarters at Kansas City, Mo., has been appointed supervisor of wages and working agreements, with the same headquarters.

B. M. Brown, master mechanic for the Southern Pacific lines with headquarters at El Paso, Tex., has been promoted to assistant superintendent of motive power and equipment with headquarters at Algiers, La.

A. H. Oelkers, whose appointment to chief mechanical engineer of the St. Louis-San Francisco, with headquarters at Springfield, Mo., has been announced, was born on October 4, 1885, on a ranch near New Braunfels, Tex. He entered railway service in 1901, as an apprentice machinist on the Southern Pacific, at San Antonio, Tex., and held this position until 1904, when he entered Purdue University. He was graduated from the university in 1907, with a degree in mechanical engineering. He re-entered the service of the Southern Pacific in September of that year, being assigned to road locomotive tests and miscellaneous work in the motive power department, with headquarters at Houston, Tex. He was promoted to head draftsman in 1910, and held this position until January, 1912, when he was promoted to mechanical engineer of the lines in Texas and Louisiana. During 1916 and 1917 he served as general shop foreman and supervisor of construction and new equipment, but resigned in August, 1918, to enlist in the U. S. Naval Aviation Service. Following his discharge from the navy in February, 1919, he was appointed master mechanic on the Louisiana lines of the Southern Pacific, which position he held until March, 1920, when he was promoted to assistant superintendent of motive power and engineering. He resigned from this position on December 31, 1922, to enter the service of the St. Louis-San Francisco as chief mechanical engineer.

A. H. Oelkers

J. W. Slack, Jr., has been appointed supervisor of the wage bureau of the Long Island, with headquarters at New York. He will report to and receive instructions from the general superintendent, to whom any question dealing with rates of pay, rules or working conditions will be transmitted for decision, in accordance with present practice.

E. M. Cooney has been appointed motive power inspector of the Chicago & Eastern Illinois, with headquarters at Danville, Ill. Mr. Cooney began railroad work as an apprentice in the boiler department of the Cleveland, Akron & Columbus—now part of the Pennsylvania system—in 1894, was made foreman boiler maker in 1904 and was engaged on special duty service under the superintendent of motive power at Toledo, Ohio, from 1912 to 1915. After serving as master mechanic of the Ohio River & Western from 1915 to 1917 he was assigned to the general superintendent of motive power's office at Pittsburgh, Pa., as general mechanical inspector of the Pennsylvania system Lines West.

Master Mechanics and Road Foremen

L. J. Gallagher has been appointed road foreman of engines of the Northern Pacific with headquarters at Missoula, Mont.

C. Peterson, acting master mechanic of the Denver & Salt Lake, with headquarters at Denver, Colo., has been appointed master mechanic.

J. C. Brown, general mechanical inspector Denver & Rio Grande Western, has been appointed master mechanic with headquarters at Alamosa, Colo.

W. B. Lieck, general foreman of the Southern Pacific at El Paso, has been promoted to master mechanic with the same headquarters, succeeding B. M. Brown, promoted.

H. L. Ellerbush has been appointed master mechanic of the Central division of the Union Pacific, with headquarters at Marysville, Kans., succeeding W. J. Kirsch, transferred.

G. C. Goff has been appointed master mechanic of the Southern with headquarters at Spencer, N. C., succeeding B. McBride who has been transferred in a similar capacity to Charleston, S. C.

W. J. Kirsch, master mechanic of the Central division of the Union Pacific, with headquarters at Marysville, Kans., has been transferred to the Kansas division, with headquarters at Kansas City, Kans.

J. A. Marshall, road foreman of engines of the Northern Pacific, with headquarters at Duluth, Minn., has been promoted to master mechanic of the Lake Superior division with the same headquarters.

J. M. Kilfoyle, terminal master mechanic of the Union Pacific with headquarters at Pocatello, Idaho, has been appointed master mechanic of the Utah division with the same headquarters, succeeding D. Gratian, resigned.

M. J. Powers, assistant superintendent of motive power of the Colorado & Southern, has been appointed terminal master mechanic of the Union Pacific with headquarters at Pocatello, Idaho, succeeding Mr. Kilfoyle, promoted.

E. Becker, master mechanic on the Chicago & North Western, with headquarters at Escanaba, Mich., has been appointed master mechanic of the Green Bay & Western, the Kewaunee, Green Bay & Western and the Ahnapee & Western, with headquarters at Green Bay, Wis., succeeding T. J. McPherson, who has resigned.

Shop and Enginehouse

P. Goggin, machinist, has been promoted to gang foreman of the Boston & Albany at West Springfield, Mass.

V. Brassard, gang foreman of the Boston & Albany, has been promoted to assistant day enginehouse foreman at West Springfield, Mass.

W. H. Dibble, assistant day enginehouse foreman at the West Springfield, Mass., enginehouse of the Boston & Albany, has been promoted to day enginehouse foreman.

E. P. Kelley, day enginehouse foreman of the Boston & Albany at West Springfield, Mass., has been promoted to general enginehouse foreman at the same point, succeeding A. L. Babcock, retired.

Anthony L. Babcock, day enginehouse foreman of the Boston & Albany at West Springfield, Mass., has been retired on a pension. Mr. Babcock was born at Petersburg, N. Y., January 16, 1853, began railroad work as a wiper at Rensselaer enginehouse and after serving as fireman, engineer and machinist was made an engine despatcher in 1897. He was promoted to road foreman of engines in 1901 and made enginehouse foreman at West Springfield in 1903.

Purchasing and Stores

A. Knodt, acting purchasing agent and storekeeper of the Denver & Salt Lake, with headquarters at Denver, Colo., has been appointed purchasing agent and storekeeper.